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INTRODUCTION.

During the summer of 1913 the Secretary of Agriculture established a board to reorganize the system of publications of the Department of Agriculture. In accordance with the proceedings of the board and the suggestions from representatives of the Weather Bureau, the "Bulletin of the Mount Weather Observatory" ceased to be published with the completion of its volume 6. Any subsequent contributions from the members of the research staff that would have been proper for that Bulletin will be incorporated in the Monthly Weather Review. The climatological service of the Weather Bureau will be maintained in all its essential features, but its publications, so far as they relate to purely local conditions, will be incorporated in the monthly reports for the respective States, Territories, and colonies.

Beginning with January, 1914, the material for the Monthly Weather Review will be prepared and classified in accordance with the following sections:

SECTION 1.—*Aerology.*—Data and discussions relative to the free atmosphere.

SECTION 2.—*General meteorology.*—Special contributions by any competent student bearing on any branch of meteorology and climatology, theoretical or otherwise.

SECTION 3.—*Forecasts and general conditions of the atmosphere.*

SECTION 4.—*Rivers and floods.*

SECTION 5.—*Bibliography.*—Recent additions to the Weather Bureau library; recent papers bearing on meteorology.

SECTION 6.—*Weather of the month.*—Summary of local weather conditions; climatological data from regular Weather Bureau stations; tables of accumulated and excessive precipitation; data furnished by the Canadian Meteorological Service; monthly charts Nos. 1, 2, 3, 4, 5, 6, 7, 8, the same as hitherto.

In general, appropriate officials will prepare the six sections above enumerated; but all students of atmospherics are cordially invited to contribute such additional articles as seem to be of value.

The voluminous tables of data and text relative to local climatological conditions that during recent years have been prepared by the 12 respective "district editors," will be omitted from the MONTHLY WEATHER REVIEW but will in future be collected and published by States at selected section centers.

The data needed in Section 6 can only be collected and prepared several weeks after the close of the month whose name appears on the title-page; hence the REVIEW as a whole can only issue from the press within about eight weeks from the end of that month.

It is hoped that the meteorological data hitherto contributed by numerous independent services will continue as in the past. Our thanks are especially due to the directors and superintendents of the following:

The Meteorological Service of the Dominion of Canada.
The Central Meteorological and Magnetic Observatory of Mexico.
The Director General of Mexican Telegraphs.
The Meteorological Service of Cuba.
The Meteorological Observatory of Belen College, Habana.
The Government Meteorological Office of Jamaica.
The Meteorological Service of the Azores.
The Meteorological Office, London.
The Danish Meteorological Institute.
The Physical Central Observatory, Petrograd (St. Petersburg).
The Philippine Weather Bureau.
The General Superintendent United States Life-Saving Service.

SECTION 1—AEROLOGY.

SOLAR RADIATION INTENSITIES AT MOUNT WEATHER, VA., DURING JULY, AUGUST, AND SEPTEMBER, 1914.

By HERBERT H. KIMBALL, Professor of Meteorology.

[Dated Washington, D. C., Oct. 30, 1914.]

In Table 1 are summarized the solar radiation measurements made at Mount Weather, Va., with a Marvin pyrheliometer during July, August, and September, 1914. For details relative to the standardization of the pyrheliometer, the number and frequency of radiation measurements, and the method of interpolating readings to the air masses given in the heading of the table the reader is referred to pages 138 and 310 of the current volume of this REVIEW.

Both the maximum and the mean radiation intensities measured in July and August, 1914, exceed those for the corresponding months in 1912 and 1913 and equal those for these months in years previous to 1912. The average intensities for September, 1914, exceed those for any previous September, and the measurements on the 28th were the highest ever obtained at Mount Weather.

From Table 10, page 483, of the current volume of this REVIEW it is seen that the maximum daily radiation for the third decade in September, 1914, which was recorded on the 28th, amounted to 535 calories per square centimeter of horizontal surface. This is the greatest daily amount ever recorded at Mount Weather during the third decade of September. Also, during the hour ending at 1 p. m. of the 28th the total radiation was 75.1 calories, which is likewise a maximum rate for this decade. Of this amount about 5 calories, or only 7 per cent, was received diffusely from the sky, a result that is comparable with Abbot's measurements on Mount Wilson. (See Table 12, page 486, in the current volume of this REVIEW.

In July and August, 1914, the skylight polarization, with the sun at zenith distance 60°, measured at a point 90° from the sun and in the same vertical circle, was below the average for these months, but higher than in the corresponding months of 1912 and 1913. In September it was above the average, and on the 28th measured 72 per cent before noon and 73 per cent after noon. These are the highest polarization measurements ever obtained at Mount Weather in September, and they have only been exceeded by measurements made in October, 1911.

At the end of September, 1914, solar radiation measurements were discontinued at Mount Weather. Most of the radiation apparatus has since been installed at the American University, Washington, D. C., where solar radiation investigations will be conducted by the Weather Bureau in coöperation with the university.

TABLE 1.—*Solar radiation intensities at Mount Weather, Va., during July, August, and September, 1914.*

[Gram-calories per minute per square centimeter of normal surface.]

Date.	Air masses.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1914. A. M.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
July 3		1.25	1.10	0.97	0.89	0.82	0.74				
11	1.27	1.07	0.86		0.59	0.49					
12						0.69	0.63	0.58	0.53		
18	1.28										
19	1.42										
20	1.27		0.95	0.91	0.79	0.75	0.70	0.65	0.61		
21	1.28	1.14	0.99	0.86	0.76	0.69	0.63	0.57			
22	1.28	1.22	1.14	1.04	0.94	0.87	0.82	0.77	0.74	0.68	0.65
27	1.30	1.14	0.98	0.78	0.68						
29	1.40	1.30	1.21	1.13	1.06	0.99	0.93	0.88	0.84	0.80	0.76
30	1.34	1.24	1.15	1.07	0.98	0.91	0.86	0.82	0.77	0.72	0.65
31	1.34	1.11	0.96	0.84	0.75		0.59				
Means	1.32	1.18	1.04	0.95	0.83	0.78	0.74	0.71	0.70	0.73	0.69
P. M.											
July 20		1.05	0.98	0.86	0.77	0.70					
21		1.00	0.82								
31		1.18									
Means		1.08	(0.90)	(0.86)	(0.77)	(0.70)					
A. M.											
Aug. 3		1.10	0.92								
7	1.07	0.84	0.66	0.59	0.52	0.44					
8	1.01										
14					0.84	0.75	0.68				
16		1.10	1.01	0.91	0.81	0.71	0.63	0.57			
17	1.28			0.83	0.76						
20		0.96	0.84	0.73	0.65	0.61	0.54	0.49	0.44	0.40	0.37
21			0.79	0.68	0.59	0.52	0.47	0.42			
22		1.30	1.17	1.10	1.02	0.95	0.88	0.80	0.74	0.70	0.66
23		1.01	0.84	0.75	0.67	0.63					
24			0.89								
30							0.79	0.75	0.69	0.62	
31	1.25	1.18	1.04	0.94	0.86	0.79	0.72	0.65	0.59	0.54	
Means	1.15	1.07	0.91	0.82	0.75	0.68	0.67	0.61	0.62	0.56	(0.52)
P. M.											
Aug. 6		0.79	0.68	0.59	0.49	0.41	0.33				
13	1.40										
19		1.04									
Means	(1.40)	(0.92)	(0.68)	(0.59)	(0.49)	(0.41)	(0.33)				
A. M.											
Sept. 4		1.22	1.11	1.00	0.91	0.84	0.79	0.74	0.69	0.64	0.59
5		1.32	1.23	1.15	1.07	1.00	0.93	0.88	0.83	0.78	0.72
7	1.27	1.14									
9		1.33	1.20	1.07							
10	1.45	1.42	1.31	1.21	1.11	1.04	0.99	0.95	0.91	0.86	0.81
13				1.14	1.06	0.99	0.93	0.88	0.83	0.79	0.75
14				1.14	1.08	1.03	0.98	0.90	0.86	0.81	0.77
18		1.30	1.21								
21			0.96	0.82	0.74	0.68	0.62				
22		1.11	0.96	0.84	0.74	0.65	0.60	0.53			
23		1.06	0.95	0.83	0.72	0.62	0.52	0.44	0.42		
26			1.31	1.23	1.14	1.05	1.00	0.94	0.89	0.86	
27		1.37	1.29	1.18	1.09	1.02	0.95	0.87	0.81	0.76	
28		1.48	1.40	1.32	1.26	1.20	1.15	1.09	1.04	1.00	0.96
29		1.28	1.17	1.07	1.00	0.94	0.89	0.83	0.77	0.71	0.67
30			1.05	0.93	0.82	0.73					
Means	(1.36)	1.28	1.17	1.07	0.98	0.91	0.86	0.82	0.80	0.80	0.75
P. M.											
Sept. 2		1.17	0.98	0.87	0.81	0.75					
9						0.85	0.77	0.71	0.66	0.61	0.57
10		1.42	1.31								
14			1.24	1.13	1.03	0.94	0.86	0.80	0.75	0.69	0.65
15		1.41	1.29	1.21	1.12	1.02	0.94	0.88	0.83	0.79	
16			1.22	1.13	1.06	1.00	0.93	0.85	0.78		
22		1.11									
26		1.33	1.24	1.13	1.05	0.97	0.90	0.85	0.83		
27		1.22			0.79						
28		1.46	1.35	1.26	1.18	1.11	1.05	1.00	0.94	0.89	0.86
29		1.31	1.23	1.15	1.05	0.94					
Means		1.30	1.23	1.13	1.01	0.95	0.91	0.85	0.80	0.74	0.69

NOTES ON OBSERVING THE ZODIACAL LIGHT.

By Maxwell Hall.

[Dated Montego Bay, Jamaica, W. I., Sept. 30, 1914.]

The zodiacal light can not be well seen unless it is nearly perpendicular to the horizon, and then it appears as a tapering cone of light which passes near and far beyond the zenith; and as the axis or central line of this light closely follows the ecliptic, this condition requires observations to be made in low latitudes, within or nearly within the tropics; and even then the conditions for the Northern Hemisphere are best satisfied in February, March, and April for the eastern branch, and in August, September, and October for the western branch, seen in the evening and morning, respectively.

The positions of these branches should be considered with respect to the sun at noon; the western branch sets before the sun so that the eastern branch is seen an hour or so after sunset, and the western branch is seen an hour or so before the following sunrise. And as after some practice the light may be seen across the whole sky, it is necessary to note on which branch observation is made.

When the zodiacal light is seen at its best its illumination is equal to that of the first or last rays of twilight; its breadth at the horizon about 21° from the sun is about 32°; and its breadth and illumination gradually decrease as the distance from the sun along the axis increases. Where the two branches meet opposite to the sun there is a considerable increase in the light, and the band there is broader; this appearance is known as "the counterglow," and it may easily be seen high up in the midnight sky when it may be very difficult to follow the branches.

Now, unless the zodiacal light is fairly perpendicular to the horizon, as already said, its light mingles with the diffused light almost always seen along the horizon at night, and then its figure becomes greatly distorted and its breadth may apparently become as large as 60° or 70°; but the less diffused light there is the smaller the breadth, until the limit of 32° is reached. Beginners are therefore advised to observe 20° or 30° above the horizon, where the figure of the zodiacal light will be seen to be perfectly uniform.

On any clear dark night, in the absence of moonlight and all artificial light, the observer should remain some time in the open air and allow his eyesight to become sensitive, so that he can easily follow the light along the ecliptic; and he will be surprised to find after 10 or 15 minutes how much wider it becomes and how much farther it extends, until at last the counterglow is reached; indeed, instead of instrumental means, he requires a level terrace to walk on, a wide expanse of sky, and aptitude to admire the whole tropical scene.

The next thing is to select a part of the light for measurement of its breadth; the Milky Way, or bright planets, may interfere, and all such disturbing causes should be avoided. Then the right-hand boundary of the light may be seen to pass over a known star or between two known stars, so that a point can afterward be made on a star-map marking its position; and similarly for the left-hand boundary. It is not essential that the line joining the two points should be exactly at right angles to the axis, but it should be nearly so. A pencil note should then be made of the conclusions arrived at with respect to the points marking the boundaries; and if much artificial light is required time must again be allowed so that the eye may become sensitive again to make another observation at another part.

The following day the observations should be reduced; the points on the boundaries should be marked in pencil on a star-map and joined by a straight line; the middle point of this line marks a certain point on the central axis; and the latitude and longitude of this point and the breadth of the light at this point can easily be found with a pair of dividers. The sun's longitude must be taken from a nautical almanac; and then the distance of the point on the central axis from the sun will be the longitude of the former minus the longitude of the latter, if the observation be made on the eastern branch; if the observation be made on the western branch it will be the longitude of the latter minus the longitude of the former.

From a series of observations a table can be drawn up showing the breadth of the light and its geocentric latitude at different angular distances from the sun, which leads to important results; but there are certain months when observations made of the latitude of certain parts of the zodiacal light are very valuable; these are the counterglow in April and October, and points 90° from the sun on both branches in January and July.

And now very simple geometrical considerations will lead the observer to conclude that he is dealing with a most interesting part of the solar system, important as every part of the solar system must be, and requiring every possible care and accuracy of observation.

In former articles the author has shown that the zodiacal light does not actually coincide with the plane of the ecliptic, but is inclined to it at an angle of 1° 45′, the ascending node being at longitude 105° 30′, so that it really coincides with the invariable plane. It was surmised that the zodiacal light was caused by the reflected light of the sun on the remaining meteoric matter after the formation of the solar system; and later it was shown that the density of this matter varies inversely as the square of the distance from the sun and inversely as the distance from the medial plane. What has been done, however, only opens fresh fields for investigation.

SHOOTING STARS REVEAL A HIGHER ATMOSPHERE.

An elaborate memoir by Prof. G. von Niessl, formerly of Brünn, now of Vienna, was lately published in the Encyklopädie der Mathematischen Wissenschaften, Band VI, in which he examines the highest altitudes at which meteors or shooting stars become visible. From these altitudes, of course, we conclude that the atmosphere must extend still higher above the earth, since the meteors must have pursued a considerable distance before, by compressing and heating the thin air, they could have thereby acquired a temperature high enough to become visible. The exact determination of the altitudes and motions of these meteors has hitherto required so much time on the part of observers and computers that comparatively few astronomers have devoted themselves to this work. But the study is of more importance to meteorology than to astronomy, and a simple photographic apparatus must be devised that will make it practicable to easily collect the exact data that will facilitate the calculation of the altitude and velocity of any shooting star, meteor, or bolide that may be recorded. But these "shooters" give us not merely their own heights and the chemical constituents of special regions of the atmosphere, they do much better; many of them produce great noises that are heard at the earth's surface and are likened to thunder or the discharge of cannon. From the records of such noises we should learn much about the differences of density in the layers of atmosphere and much about the atmospheric movements that are then prevalent at altitudes far beyond the reach of ordinary balloons. We know that our atmosphere is held by gravity to the earth and that both are revolving rap-

idly around our polar axis, but this idea must be extended so as to include regions that are far higher than has hitherto been assumed. Our atmosphere is not merely that region in which clouds and rains occur; it is not merely a troposphere within which the highest cirrus clouds are seen; it is not merely a stratosphere within which there are but slight vertical temperature changes going on and one that is accessible to our highest sounding balloons; it is not merely a high layer of air within which the aurora occurs; it includes the region within which shooting stars become first visible and which may be the frontier or boundary of the earth considered as a planet. It may be doubted whether there is a definite boundary to our atmosphere; probably our lower air merges imperceptibly into an interplanetary space within which other planets, the zodiacal dust ring, and various gases are free to move according to the laws of universal gravitation, centrifugal force, and inertia. This material region in space binds our whole planetary system together as a unit. The gases, the atoms, the electrons, the corpuscles of Sir J. J. Thomson—all the obscure electrical, molecular, and atomic phenomena, so far as known—seem to belong to both the sun, the planets, and the attendant space. We are forced to this train of thought whenever we collate the observations of any great meteor, such as that of Christmas Eve, 1873, or that of February 18, 1912.[1]

[1] The latter meteor was studied by Cuno Hoffmeister, of Sonneberg, Saxe-Meiningen, whose results are published on pages 32–46 of "Mitteilungen von der Freunden der Astronomie und Kosmische Physik," April, 1913, 23, Heft 2.

The importance of the study of bolides, shooting stars, and small meteors led the Astronomical Society of Antwerp (Anvers) to establish an international scientific organization (the Bureau Central Metéorique), whose founder and first president was Carl Birkenstock of Hamburg, and whose secretary is Dr. Cuno Hoffmeister of Sonneberg, Saxe-Meiningen. (*See* Minerva, 1913–14, p. 582.)

Sonneberg is in latitude 50° 20′ north and longitude 11° 10′ east of Greenwich; Jena is in latitude 50° 55′ north and longitude 11° 35′ east of Greenwich; hence Jena is about 44 miles distant from Sonneberg, bearing north 30° east. According to the Vierteljahrschrift of the German Astronomical Society for 1914, page 49, Dr. Nagel of Baku, at present observer at Jena Observatory, by an arrangement with Dr. Cuno Hoffmeister of Sonneberg, has maintained simultaneous observations of meteors during the several star showers of 1913 and will maintain them during 1914, if nothing prevents. The meteors of these star showers are small compared with the bright bolides that occasionally occur, but every form of meteor has its value in the study of the upper atmosphere. So long as such meteors are invisible they may be considered as astronomical bodies belonging to the solar system, but when they become visible by reason of their compression of the upper atmosphere they become an integral part of the earth considered as a planet, consisting of an agglomeration of solids, liquids, and gases.

SECTION II.—GENERAL METEOROLOGY.

INFLUENCE OF TERRESTRIAL ROTATION ON THE CONDITION OF THE ATMOSPHERE AND OCEAN.

By J. W. SANDSTRÖM.

[Dated, Statens Meteorologiska Centralanstalt, Stockholm, July 30, 1914.]

1.

The more one seeks to comprehend the atmospheric and oceanic phenomena, so much the more does terrestrial rotation come prominently to the front as one of their most important causes. Indeed, its effects appear in a very puzzling and peculiar manner, since numerous phenomena are quite inverted by reason of the terrestrial rotation. If the earth were at rest the atmospheric pressure at sea level would increase with increase of latitude, whereas on our rotating earth almost the opposite is the case. On a stationary earth warm light air would ascend to higher levels and cold, heavy air would sink downward, whereas on the rotating planet the opposite procedure is more frequent since, as a rule, the ascending air of cyclones is cold and specifically heavy, while the descending air of anticyclones is warm and specifically light.

It is no easy matter to clearly understand the actual method of action of the earth's rotation. I think this is due primarily to the fact that man is not provided with any sense that enables him to appreciate this rotation. From childhood on we are accustomed to regard the visible portion of the earth's surface as at rest. To be sure, we all know that the earth does really rotate and we can imagine this, but we have no sense by which to feel it. At times, perhaps, some industrious astronomical observer has had an occasional illusion of a rotating earth; but this true reality must have impressed him as an unreal deception. On the other hand, the constant deception that the earth is at rest, although it is really rotating, impresses the observer as being the true state of affairs.

Under these conditions it is indeed very natural that even the effects of the earth's rotation should appear foreign to us. In order to deduce them one must employ Coriolis's Theorem.[1] Undoubtedly this is adequate to compute all the consequences of terrestrial rotation, but its application[2] is not simple and this, I believe, is because the results impress us as strangely as does the fact of terrestrial rotation itself. For example, Coriolis's Theorem enables one to understand why, in the cyclone, specifically heavy air has a tendency to ascend and to compute the force that drives it upward. But the computation is distasteful to us, and we draw the inference that the calculation is erroneous because the results appear so contrary to what we expected. On the other hand, a being who can feel the terrestrial rotation would probably find it very natural that specifically heavy air has a tendency to ascend and specifically light air to descend. That person would find it easy to apply Coriolis's Theorem, because the resulting conclusions would be in harmony with his sensations.

This lack in the human senses seems to me to be one of the most serious obstacles to the introduction of dynamic methods in practical meteorology and hydrography. It is a simple matter to record the actual conditions and their changes, as well as to work up the observational material already collected from different points of view. But as soon as one attempts a near approach to the inner relationships of the phenomena enormous difficulties spring up. Thus, we have good grounds for assuming that the distribution of atmospheric pressure is intimately related to that of temperature and heat. It is also generally conceded that if this fundamental relationship could be formulated, purely practical meteorology would be greatly benefited. At first glance, also, the task seems to be very simple; if the air is warmed anywhere there it becomes specifically light and no longer presses so heavily upon the underlying surface. In consequence the air pressure decreases, i. e., a barometric depression is formed. This simple and clear consideration holds true for the conditions of the equatorial region between the horse latitudes where terrestrial rotation has little influence, but it does not at all apply in the higher latitudes. In these latter regions the lowest atmospheric pressure generally occurs precisely where the air is cold and specifically heavy (that is in the cyclones) and consequently ought to be pressing most heavily upon the underlying surface. This paradox is all the more exasperating because it seems to be quite uncalled for. Consequently we content ourselves with reporting the problematical phenomenon which contradicts all logic, and are not willing to suggest an explanation.

2.

I think that the detailed reasons above given make it of special importance to utilize any possible means that can help to visualize the effect of terrestrial rotation upon gases and liquids. Thus far I have found the best means to be hydrodynamic experiments with rotating vessels. These experiments present in an astonishingly simple manner some of the most important paradoxical phenomena of air and sea, and one can readily ascertain their causes because we are able to sense the rotation. For this reason such experiments should be employed to demonstrate to university classes the influence of the earth's rotation upon atmospheric and oceanic processes.

While performing and discussing these experiments one is soon led to a line of thought different from that of Coriolis, much more limited to be sure, but one that in many cases explains the processes in a simpler and less constrained manner. Indeed, one may consider these experiments from two different standpoints, both of which are useful. On the one side we may imagine that a very small intelligent individual is on the rotating vessel, a being of such small size and of such limited observational power that he can not recognize the rotation of the vessel. To such a small individual many of the processes in the vessel would appear extraordinarily

[1] Gustav Gasper Coriolis (1792–1843, Sept. 19, Paris) was an eminent French physicist; he was elected a member of the Académie des Sciences (Paris) in 1836. His Theorem was the kinematical proposition that the acceleration of a point relative to a rigid system is the resultant of the absolute acceleration, the acceleration of attraction, and the acceleration of compound centrifugal force. This proposition was probably first published in 1829 in his work "Traité de Mécanique," Paris, 1829, and in its second edition of 1844.

Director Nils Ekholm presents an exposition of Coriolis's Theorem in this REVIEW for June, 1914, 42:331–333.—[C. A.]

[2] See Nils Ekholm in MONTHLY WEATHER REVIEW, June, 1914, 42:333, fig.

problematical. For example, by experiments carried out on a small scale he would find that liquids and gases specifically lighter than their surroundings will strive upward; but would find just the opposite rule when he regards the conditions in the vessel on a large scale. At first he would think his observations were incorrect or affected by local influences; gradually, however, the observations would be confirmed. Eventually numerous observations would lead him by indirect ways to the conclusion that the vessel probably has a rotating motion and then mathematical reasoning would enable him to determine how this new fact had influenced the conditions. Thus he would have deduced Coriolis's Theorem, and finally by applying that theorem he would succeed in satisfactorily explaining several of the observed peculiarities.

The second standpoint regards the rotating vessel from without and observes the phenomena taking place there. In this case it would appear as a result of the rotation of the vessel, that rotary movements predominate therein, movements to which one can directly apply the simple and comprehensible laws and experiments relating to centrifugal force. Much that appeared problematical under the former point of view now appears quite natural.

On applying to the earth the first method of consideration, that of experimentation, the small, intelligent individual of defective senses is represented by man himself. The second method of consideration presents matters as they would appear to an observer outside of the earth studying the processes of the atmosphere and the oceans from such a position. He would see a series of grand vorticular motions to which he would apply the principles of the law of centrifugal force. The advantage of this method of consideration consists in the fact that one may thereby see and judge of the whole absolute motion and the associated forces without any intermediary. In the former method one is concerned with two motions: The relative motions of the atmosphere or of the ocean water, as referred to the earth's surface, and the motions of the earth's surface as the result of its rotation. The compounding of these two motions and of the forces that bring them into existence is not always a specially easy problem. Nevertheless, so long as man possesses no external sense by which he can feel the earth's rotation, Coriolis's Theorem will be indispensable for him, and the hydrodynamic experiments with rotating vessels will be an excellent means of becoming practically acquainted with this law. The experiments should be considered first from the second or absolute point of view and then immediately transferred to the first or relative standpoint. By this comparison of the two methods one will gradually acquire the ability to intuitively take immediate account of the effect of terrestrial rotation when discussing the relative movements that we observe on the earth. I designate this acquirement as one of the most important objects of the present dynamic meteorology.

3.

In order to demonstrate this comparative method of discussion I need describe only a single experiment. Suppose it be desired to present experimentally the heaping up of the warm ocean water in the horse latitudes—there is provided a vessel of the dimensions $30\times10\times10$ centimeters, having its longitudinal walls of glass. This vessel is filled to a depth of about 3 centimeters with fresh water, and then an equally deep layer of salt water is [gently] introduced beneath the fresh water. One of the water strata is colored with ink so that the form of its surface can be readily observed. Now, with the aid of a pair of bellows, a tube and the perforated spout of a watering pot, we direct a current of air down upon the water surface as indicated in figure 1.

At once it becomes clear that the bounding surface between the two strata of water bulges upward beneath

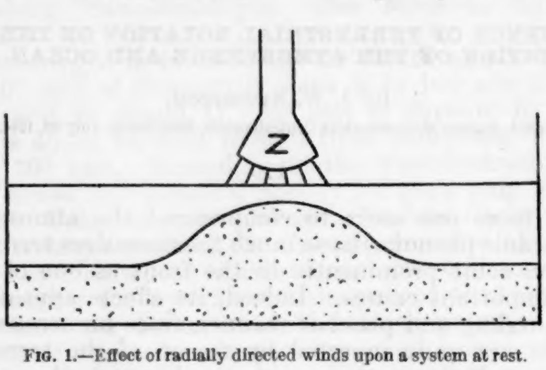

FIG. 1.—Effect of radially directed winds upon a system at rest.

the downward current of air; this is a natural result of the air blowing down upon the surface water and driving it toward the two ends of the vessel. We now place the vessel of water upon a rotatory table and set the table with the vessel in slow rotation about a vertical axis by means of a rotator. On blowing down upon the water surface as before, we find that the bounding surface of the two

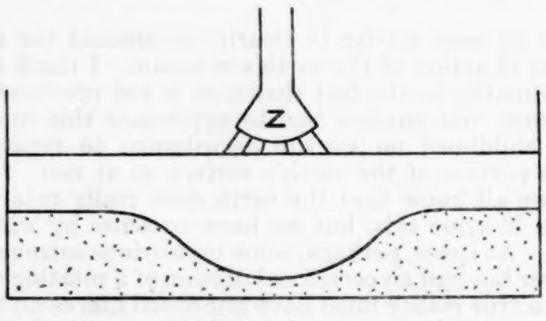

FIG. 2.—Effect of radially directed winds upon a rotating system.

layers does not bulge upward at a point beneath the spout but, on the contrary, is depressed as shown in figure 2. This heaping up of the surface stratum beneath the air current is obviously associated intimately with the rotation of the vessel. From the experiment one readily concludes that the heaping of ocean water under the horse latitudes is the direct result of the earth's rotation in combination

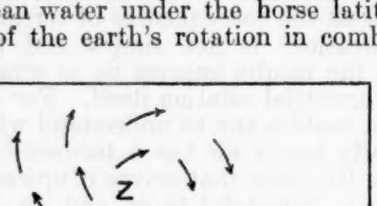

FIG. 3.—Relative motion of radially directed winds at the surface of a rotating system. (Viewed from above.)

with the anticyclonic atmospheric conditions prevailing there.

We may now endeavor to explain this phenomenon from the point of view of the small imaginary being that was cited in Section 2. This being observes the air movement relative to the rotating vessel and perceives that the air blows spirally outward from a center. (See fig. 3.)

This air movement produces also an anticyclonal circulation in the water, whereby on account of the deflective force this rotation comes into action and drives the water toward the right hand; in other words, it presses toward the center and the water heaps up at the center.

From the second point of view we see at once that the vessel is in rotation and then that there is air blowing radially from a central point upon the water surface. (See fig. 4.) The lower stratum has the same velocity of rotation as the vessel itself, but the rotation of the surface water is hindered by the radial air currents, so that this surface water moves somewhat more slowly than does the vessel. Accordingly the centrifugal force of the lower water stratum exceeds that of the upper. Hence the lower water is forced outward while the upper stratum collects in the center.

4.

This example presents the difference between the two methods of consideration. When it is desired to apply the second or absolute method of consideration to hydrologic and meteorologic processes, one must first of all recall that, in consequence of the earth's turning about its axis, its surface is everywhere in cyclonic rotation and that its velocity of rotation is determinable by the Foucault Pendulum experiment. If the earth's angular velocity of rotation is w, then the angular velocity of any point on the earth's surface is $w\sin\phi$, where ϕ is the geographic latitude of the place in question, and the time required by the earth to complete one rotation amounts to $24/\sin\phi$ hours. These reflections show that air that is apparently at rest actually possesses a considerable cyclonic circulation; in fact even the air caught in the familiar anticyclonic whirl actually possesses a cyclonic rotation. Accordingly it is clear that air apparently at rest is exposed to a considerable centrifugal force which is reinforced under cyclonic conditions and weakened under anticyclonic circulation. These facts explain completely the temperature distributions found within cyclones and anticyclones. In a cyclone the cyclonic rotation at first increases with altitude until at a certain height it attains its maximum, above which height the rotation suffers a diminution upward. The centrifugal force of the air is greatest at that level where the cyclonic rotation is strongest; hence at this level the air is driven most strongly outward, while below this level consequently the air is drawn upward and above this level it is drawn downward. Therefore, the air undergoes dynamic cooling below the level of maximum cyclonic rotation and dynamic warming above that level. This is the origin of the temperature distribution that has been found in cylcones. In an anticyclone the anticyclonic rotation has its maximum at a certain level where the centrifugal force is smallest, and from that level the centrifugal force increases both upward and downward. Consequently, below this level the air will be drawn downward and above it will be drawn upward; therefore, below this level the air will be warmed dynamically and above it will be cooled—deductions that agree with the observed temperature-distribution within anticyclones.

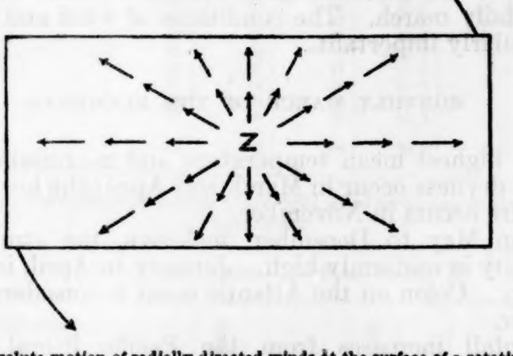

FIG. 4.—Absolute motion of radially directed winds at the surface of a rotating system. (Viewed from above.)

As is well known, the west—east drift of the atmosphere in middle and higher latitudes forms a gigantic polar cyclone. Now this west—east drift has its maximum at a certain level and diminishes both upward and downward therefrom. At the level of the maximum drift the centrifugal force is the greatest; below that level the air of the polar regions is drawn upward and above it the air is drawn downward; therefore, beneath this level the temperature of the air at the poles is lower than it is at the Equator, while above this level the air is warmer above the region of the poles than it is [at the same level] over the Equator. This agrees with recent observations made at great altitudes with balloons and kites at the poles and the Equator.

In Sweden certain summers, e. g., 1901 and 1914, have experienced long-continued dry weather that has been very disadvantageous to agriculture. The sun burns in a sky that is perfectly free of clouds; day and night the air temperatures are almost unbearable, rain is rare and irregularly distributed only as an accompaniment of sparsely scattered thunderstorms. Man is amazed to find that this highly heated air does not acquire a tendency to rise, for certainly it is considerably lighter than the air that overlies the countries bordering Sweden. On the contrary, some tremendous power seems to be forcing the air down upon Sweden, apparently a power far greater than the ascensional force due to the difference in specific gravity. To explain this downward force it is but necessary to assume that at some distance above [the earth] there is an anticyclonic [atmospheric] circulation around Sweden. The centrifugal force of the air is greater near the earth's surface than it is at some distance above, and therefore the air being thrown out in all directions it is strongly drawn down over Sweden. Hence the cloudless, rainless sky, the strong insolation, and the high air temperature. To explain the whole phenomenon, it is sufficient if west winds prevail in northern Scandinavia and easterly winds in southern Scandinavia. It is but a direct and simple consequence of the meteorological conditions over the North Atlantic on one side and southern Europe on the other.

We may explain the pressure distribution within cyclones and anticyclones as follows: In the cyclonic circulation of the atmosphere the centrifugal force is reinforced, and consequently barometric depressions are formed as in the familiar case of vortical movements at the surface of a body of water; on the other hand, in anticyclonic circulations centrifugal force is weakened, permitting a consequent increase of air and of pressure. This point of view makes many hydrographic processes also easily understood. Thus, in the horse latitudes the surface water of the Atlantic ocean is driven around in an anticyclonic circulation by the prevailing winds. Consequently, this surface water possesses a weaker centrifugal force than the bottom layers which lie in the depths of the Atlantic Basin and rotate with the rigid earth. The bottom layers of the Atlantic are, in consequence, driven laterally outward toward the rim of their basin more strongly than is

the surface water. The result is that the warm surface water in the center of the anticyclonic whirl, the Sargasso Sea, is there drawn downward until it reaches even the greatest depths of the Atlantic.

In the central region of the Skagerrack one always finds the cold bottom water at a very slight depth. Although the surface water is relatively warm in summer and fall, one meets, at depths of 5 or 10 meters, with water having a temperature but a few degrees above 0°C. Along the shores of the Skagerrack, on the other hand, this cold water is not met with until considerable depths have been attained. It thus appears that there is a bulging up of the cold water in the Skagerrack. Now, it is known that the surface water of the Skagerrack has a pronounced cyclonic circulation, since there are two currents, one of which comes from the North Sea, hugging the Danish coast, the other flows from the Baltic following the southern coast of Norway. The cyclonic movement of the surface water, thus produced, signifies an intensified centrifugal force of the same whereby the water of the lower strata in the center of the Skagerrack is drawn upward.

It would be easy to multiply such examples, but I shall leave that to those readers of this essay who are interested in the methods I have described. They are easy to adopt and afford very simple explanations of a large number of meteorological and hydrographical phenomena.

DAILY MARCH OF THE METEOROLOGICAL ELEMENTS IN THE PANAMA CANAL ZONE.[1]

By Hofrat Prof. Dr. JULIUS VON HANN.

[Presented to the Imperial Academy of Sciences, Vienna, Mar. 26, 1914.]

For a number of years I have received regularly from the Chief Engineer at Culebra, Canal Zone, and at the suggestion of Prof. Cleveland Abbe, of Washington, D. C., a manuscript copy of the bihourly readings of the meteorological elements (pressure, temperature, and relative humidity) for the stations in the Canal Zone. I felt to a certain extent honor bound not to permit these valuable copies, which are sent to a very limited number of persons, to lie unused, and therefore propose to communicate the results of my computations. I have taken the mean hourly pressures for four or five years at Alhajuela, on the Rio Chagres about 10 kilometers above Gamboa, from an existing publication.[2] The stations and their geographical coordinates are given in the following table:[3]

Meteorological station.	Aspect.	North latitude.	West longitude.	Altitude. (M. S. L.)
		° ′	° ′	*Feet.*
Ancon (Panama)	Pacific coast	8 57.6	79 33	86.4
Alhajuela	Inland	9 12.3	79 37	140
Colon	Atlantic coast	9 22	79 54.5	4
Cristobal (dock)[4]	do	9 21.1	79 55.5	(?)
Culebra	Pacific inland	9 03	79 39.3	384

This table is based on data furnished October 27, 1914, in a letter from George W. Goethals, Governor of the Panama Canal. A sailing chart of the Canal[4] is now available.

The mean pressures are not corrected for gravity, but they are reduced to sea level. The barometer correction is also given for Alhajuela and was used by me in calculating the mean. The other barometer readings are probably also corrected since the yearly means agree with those for Alhajuela; but the monthly means for the latter station are not in good agreement with those for the other stations. This is probably due to the fact that the means are for other series of years (1900–1904, in part for 1899–1903; while my stations are for 1907–1912 or 1908–1913, with a few gaps). In order to better judge of the causes underlying the monthly differences in the daily march of the meteorological elements, it will be well to consider first the monthly means of the meteorological elements before discussing their daily march. The conditions of wind and rain are particularly important.

MONTHLY MARCH OF THE ELEMENTS.

The highest mean temperature and maximum atmospheric dryness occur in March and April; the lowest temperature occurs in November.

From May to December, inclusive, the atmospheric humidity is uniformly high. January to April, inclusive, are dry. Colon on the Atlantic coast is considerably the moister.

Rainfall increases from the Pacific litoral to the Atlantic coast (Ancon has 181 centimeters, Colon 318 centimeters). From January to March, inclusive, it is very dry; during these three months Ancon receives but 3.7 per cent, Culebra but 3.3 per cent, and Colon 5.5 per cent of the respective annual rainfalls. April is the transition period to the rainy season, with 4 per cent, 3.4 per cent, and 3.2 per cent, respectively. On the Pacific slope the principal rainy months are May and October and November. On the Atlantic coast at Colon the rainiest months are July and October. In the case of Alhajuela I have also computed the average rainfall and the number of rain days for the period to which the daily pressure march corresponds.

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[1] The present important paper is a translation of the following:
Hann, J. v. Der tägliche Gang der meteorologischen Elemente am Panamakanal. (Vorgelegt in der Sitzung am 26. März 1914.) *Aus den* Sitzungsb. d. Kaiserl. Akad. d. Wissens. in Wien, Math.-naturw. Kl., Jänner 1914, **123**: 171–204. Wien. 1914. 34 p. 8°.

[2] **Abbot, H. L.** Hourly climatic records on the Isthmus of Panama. MONTHLY WEATHER REVIEW, Washington, June, 1904, **32**: 267–272.

[3] Prof. Hann adopted the following coordinates and altitudes for his work:
Ancon, latitude, 8° 57′ north; longitude, 79° 31′ west; altitude, 28 meters.
Culebra, latitude, 9° 02′ north; longitude, 79° 40′ north; altitude, 123 meters.
Alhajuela, latitude, 9° 12′ north; longitude, 79° 37 west; altitude, 44 meters.
Colon or Cristobal, latitude 9° 22′ north; longitude, 79° 55′ west; altitude, 10 meters.
But he states explicitly that these are only approximate, since they were not given in the publications available to him, and he had to estimate them from a very small sketch map in the Proceedings of the American Society of Civil Engineers, New York, January, 1913, **39**, no. 1. There is no serious discrepancy between the two sets of figures.
Culebra meteorological station was discontinued September 12, 1914.
Ancon station was moved to the near-by Balboa Heights, altitude of barometer cistern 118 feet, October 1, 1914.—[C. A., jr.]

[4] **Isthmian Canal Commission.** "Chart of the Panama Canal, 1904–1914. . . . Scale 1:40,000. Latitudes and longitudes are based on the Panama-Colon datum adopted in 1911. [U. S. Hydrographic Office.]" This chart is issued in two sheets, and is intended to serve for the navigation only of the canal; it gives no reliable topographic information beyond general outlines and does not extend to Alhajuela.—[C. A., jr.]

TABLE 1.—*Monthly averages of pressure and temperature in the Panama Canal Zone.*

Months.	Sea-level pressures.				Temperatures (true means).			
	Ancon.	Culebra.	Alhajuela.	Colon.	Ancon.	Culebra.	Alhajuela.	Colon.
	Mm.	*Mm.*	*Mm.*	*Mm.*	°*C.*	°*C.*	°*C.*	°*C.*
January	757.7	757.8	757.8	758.6	25.7	24.6	26.0	26.3
February	*58.1*	*58.3*	*57.8*	*59.1*	25.9	24.8	27.0	26.2
March	57.9	58.1	57.7	59.0	26.4	25.2	27.2	26.6
April	57.6	57.7	57.3	58.5	*26.6*	*25.7*	*27.3*	*26.6*
May	57.5	57.7	57.6	58.1	25.9	25.3	26.1	26.4
June	57.6	57.7	57.4	58.0	25.8	25.2	26.5	26.2
July	757.6	757.7	757.7	758.2	25.8	25.1	26.2	26.2
August	57.4	57.6	57.7	57.8	25.8	25.0	26.5	26.2
September	*57.1*	*57.4*	*58.0*	*57.6*	25.8	24.9	26.4	26.1
October	57.3	57.6	58.1	57.7	25.2	24.5	26.0	*25.5*
November	57.1	57.3	57.9	57.5	*24.9*	*24.2*	*25.9*	25.7
December	*57.0*	*57.2*	57.6	57.9	25.5	24.6	26.1	26.1
Year	757.5	757.7	757.7	758.2	25.8	24.9	26.4	26.2

TABLE 2.—*Monthly averages of atmospheric moisture in the Panama Canal Zone.*

Months.	Relative humidity.			Vapor pressure.		
	Ancon.	Culebra.	Colon.	Ancon.	Culebra.	Colon.
				Mm.	*Mm.*	*Mm.*
January	77	79	80	18.0	18.2	20.3
February	75	78	80	18.6	18.0	20.2
March	*72*	*74*	77	18.6	17.8	20.0
April	77	78	80	20.0	19.0	20.7
May	85	85	85	21.1	19.2	21.7
June	86	88	87	21.2	21.0	22.0
July	86	87	87	21.2	20.7	22.0
August	86	88	87	21.7	20.7	22.0
September	87	88	87	21.6	20.4	22.0
October	87	89	88	20.8	20.5	20.2
November	88	89	88	20.0	20.1	21.4
December	83	85	85	20.1	19.5	21.3
Year	82	84	84	20.2	19.6	21.1

TABLE 3.—*Percentage frequency of the eight wind directions in the Panama Canal Zone.*

Wind directions.	Dry season.			Rainy season.			Year		
	Naos.	Gamboa.	Colon.	Naos.	Gamboa.	Colon.	Naos.	Gamboa.	Colon.
North	39	43	51	24	18	10	31	24	32
Northeast	9	10	46	5	10	0	7	15	17
East	3	3	0	7	3	10	5	4	3
Southeast	5	0	0	10	7	8	6	3	4
South	1	0	1	15	10	32	6	3	16
Southwest	0	1	0	7	7	10	2	3	6
West	3	1	0	13	9	11	13	5	7
Northwest	40	14	0	19	11	12	29	16	9
Calm	0	28	1	0	25	7	1	27	6
Northerly	88	67	97	48	39	22	67	55	58
Southerly	6	1	1	32	24	50	14	9	26

In this table Naos, on the Pacific coast, represents Ancon, Gamboa represents Culebra. I have no wind records for Ancon and Culebra.

TABLE 4.—*Monthly average rainfalls in the Panama Canal Zone.*

Month.	Ancon (16 yrs.).	Culebra (22 yrs.).	Alhajuela (14 yrs.).	Colon (42 yrs.).	Alhajuela.*		Ancon.	Culebra.	Colon.
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Days.*	*Per ct.*	*Per ct.*	*Per ct.*
January	26	44	31	101	33	7.2	1.4	1.8	3.1
February	*22*	*14*	20	*37*	4	2.0	1.2	0.7	1.1
March	*20*	*17*	*17*	*42*	16	3.0	1.1	0.8	1.3
April	70	97	82	104	100	8.6	4.9	4.4	3.2
May	**227**	**284**	324	315	287	21.7	**12.4**	**12.8**	9.6
June	207	225	327	339	262	24.2	11.5	10.0	10.3
July	207	242	**336**	**416**	365	23.8	11.6	10.7	**12.6**
August	191	267	332	381	324	23.0	10.6	10.8	11.6
September	*189*	285	*295*	*318*	306	19.6	10.4	12.6	9.7
October	**278**	293	343	363	377	23.2	**15.3**	**13.0**	11.0
November	265	**312**	**262**	**555**	410	23.8	**14.7**	**13.8**	**16.9**
December	106	195	180	313	167	14.8	5.9	8.6	9.6
Year	1,808	2,275	2,649	3,284	2,651	194.9	100.0	100.0	100.0

* Five years corresponding to those of barometric observations.

DAILY MARCH OF PRESSURE.

The equations for the daily pressure march of the individual months I have computed from the hourly pressure means for Alhajuela only; for the semidiurnal period, however, I have also deduced the constants of the daily march for the 12 months from the records at Ancon and Culebra. It will appear that Colon does not agree well with the other stations, its amplitudes are too small. In the equations $x=0$ for midnight (local time). The tables of bihourly means for Ancon, Culebra, and Colon are prepared for seventy-fifth meridian time (i. e., Washington time). Gen. Abbot's paper[2] made no mention of the time employed and at first I thought that "Washington time" was its standard also. But it is plain that local time was meant, otherwise the difference of the phase time A_2, compared with other localities, would be too large and in general A_2 would become too great.

I find the following unreduced average annual values for A_2:

Ancon, 153.5, or reduced to local time, 162.5.
Culebra, 147.3, or reduced to local time, 156.7.
Colon, 141.6, or reduced to local time, 151.4.

Probably the phase-angle for Colon is too small, for such great differences within such small distances can scarcely occur in the case of A_2. The reduced values for Ancon and Culebra show a mutual difference of but 5.8°, i. e., about 12 minutes of time, which is permissible. The mean [of the three] is 159.6 and is in good agreement with the known phase-time of the tropical semidiurnal oscillation of pressure. But if Washington time is assumed, Alhajuela would give $A_2=175.9$, an altogether improbable high value. The unreduced value of $A_2=166.7$ is already a strikingly high one. Therefore, I assume that the observations at Alhajuela were made at local time.

The harmonic constants of the diurnal barometric march are given in the following table:

TABLE 5.—*Constants of the harmonic analysis of the daily march of atmospheric pressure at Alhajuela, Canal Zone (9° 12′ N., alt. 44 m.).*

Month.	p_1	q_1	p_2	q_2	A_1	A_2	a_1	a_2
					°	°		
January	+0.56	+0.81	+0.11	−0.75	34.4	171.6	0.98	0.76
February	+0.56	+1.04	+0.24	−0.75	28.3	162.6	1.18	0.79
March	+0.56	+1.18	+0.34	−0.75	25.3	155.6	1.31	0.82
April	+0.44	+0.94	+0.30	−0.69	25.1	156.4	1.04	0.75
May	+0.38	+0.62	+0.14	−0.63	31.5	164.5	0.73	0.65
June	+0.52	+0.67	+0.11	−0.59	37.9	169.6	0.85	0.60
July	+0.49	+0.63	+0.22	−0.60	37.9	159.0	0.80	0.65
August	+0.55	+0.69	+0.14	−0.67	38.6	168.5	0.88	0.68
September	+0.54	+0.81	+0.13	−0.79	33.9	170.6	0.97	0.80
October	+0.49	+0.76	+0.12	−0.78	32.6	171.0	0.90	0.79
November	+0.48	+0.64	+0.08	−0.80	36.8	179.4	0.79	0.80
December	+0.54	+0.82	+0.12	−0.73	33.4	170.5	0.99	0.74
Year	+0.51	+0.80	+0.17	−0.75	32.4	166.7	0.95	0.73

$p_1 \cos x+q_1 \sin x+p_2 \cos 2x$, or $a_1 \sin(A_1+x)+a_2 \sin(A_2+2x)$.

I have computed the 8-hour period of the pressure for Alhajuela only. The regular annual period for the amplitude a_3 is not clearly expressed in 4- or 5-year means. I find the following equation for this annual period:

$$0.015 \sin(11.7°+x)+0.008 \sin(128°+2x).$$

It shows a maximum in May and a minimum in September. The seasonal means are, by direct averages,

Winter, 0.039 mm.; Spring, 0.041 mm.; Summer, 0.043 mm.; Autumn, 0.018 mm.; Year, 0.035 mm.

while according to the above equation the computed seasonal means would be

Winter, 0.037; Spring, 0.041; Summer, 0.032; Autumn, 0.013.

The annual march of these small magnitudes lies within their limits of error; and the annual mean agrees in amplitude and phase-time with the computed values for other localities.

The diurnal variation of atmospheric pressure naturally has its maximum amplitudes in the dry season—February to April—and its minimum amplitudes in July (*not* in the wettest month). The annual march of the amplitudes of the semidiurnal variation is of greater interest. The maxima at about the time of the equinoxes and the low minimum in June and July are specially characteristic. I have computed these amplitudes from a periodic series, and the resulting values are presented in Table 6.

TABLE 6.—*Annual march of the amplitudes and phase-times of the diurnal barometric variation.*

Month.	Alhajuela.				Ancon and Culebra.		
	a_1	a_2	A_1	A_2	a_2	A_2	
			(True time.)			Approximate mean.	Reduced to local and true time.
January	0.94	0.76	35.1	**174.1**	0.95	155.8	**170.0**
February	1.12	0.80	32.6	170.3	0.98	151.8	168.2
March	**1.23**	**0.81**	28.2	161.9	**0.98**	149.8	163.4
April	1.18	0.75	*26.8*	*158.2*	0.93	149.3	158.5
May	0.94	0.66	30.5	161.8	0.84	147.0	154.3
June	0.72	*0.60*	36.3	165.4	0.73	144.5	*153.8*
July	*0.68*	0.63	**39.4**	166.8	*0.72*	144.0	156.0
August	0.82	0.70	38.3	168.8	0.78	144.5	155.9
September	0.98	0.78	33.5	167.6	0.88	149.0	155.6
October	**1.02**	**0.81**	30.4	165.7	0.95	154.4	156.3
November	0.93	0.78	31.1	167.4	**0.97**	157.7	159.3
December	*0.87*	*0.75*	33.4	170.8	0.96	157.6	164.6
Year	0.95	0.735	33.0	166.6	0.89	150.6	159.7

AHAJUELA.

$$a_1 = 0.15\sin(58.8+x)+0.17\sin(305.2+2x).$$
$$a_2 = 0.075\sin(118+x)+0.061\sin(315.0+2x).$$

ANCON and CULEBRA.

$$a_2 = 0.123\sin(95.2+x)+0.056\sin(289.7+2x).$$

In the following are given the equations for the daily barometric march at the extreme seasons, the dry season (February and March) and at the rainy season (October and November). Colon shows too small amplitudes and a divergent behavior during the wettest months, while the driest month shows the greater amplitudes.

Daily barometric march for the year, the driest and the wettest months.

Ancon (shore of the Pacific).

February and March, $0.78 \sin (10.3°+x)+0.90 \sin (152.5°+2x)$.
October and November, $0.43 \sin (2.5° +x)+0.91 \sin (159.9°+2x)$.
Year, $0.55 \sin (7.5° +x)+0.85 \sin (153.5°+2x.)$

Culebra (island on Pacific slope).

February and March, $0.98 \sin (16.6°+x)+1.04 \sin (148.1°+2x)$.
October and November, $0.64 \sin (153° +x)+0.96 \sin (153.5°+2x)$.
Year, $0.76 \sin (18.4°+x)+0.92 \sin (147.3°+2x)$.

Alhajuela (interior).

February and March, $1.24 \sin (26.8°+x)+0.80 \sin (159.1°+2x)$.
October and November, $0.84 \sin (34.7°+x)+0.80 \sin (175.2°+2x)$.
Year, $0.95 \sin (32.4°+x)+0.73 \sin (166.5°+2x)$
$+0.03 \sin (350.1°+3x)$.

Colon (shore of the Atlantic)[5].

February and March, $0.55 \sin (1.3° +x)+0.67 \sin (137.7°+2x)$.
October and November, $0.61 \sin (18.6°+x)+0.85 \sin (152.5°+2x)$.
Year, $0.55 \sin (12.8°+x)+0.74 \sin (141.6°+2x)$.

The following rough differences between the daily marches for the dry and the wet seasons are of interest:

TABLE 7.—*Differences between the daily march of atmospheric pressures in the dry season and the rainy season. (Dry—Rainy.)*

	Midnight.	2 a	4 a	6 a	8 a	10 a	Noon.	2 p	4 p	6 p	8 p	10 p
Ancon	22	**40**	38	20	7	1	0	−16	−29	*−37*	−28	−17
Culebra	17	27	**28**	25	10	13	3	−16	−41	*−54*	−21	3
Alhajuela	26	**40**	41	25	26	24	17	−14	−57	*−60*	−43	−15
Mean	22	**36**	32	23	14	13	7	−15	−42	*−50*	−31	−10

The pressure during the dry season is higher by night and lower by day than it is during the rainy season. This is also the well-known relation of the daily pressure march over ocean and coast as compared to that over inland stations. As is to be expected, this difference increases inland, as may be seen by comparing Ancon (coast) with Culebra and Alhajuela (inland). Colon on the Atlantic coast, behaves quite differently, as appears from Table 8:

TABLE 8.—*Difference between the daily march of the atmospheric pressures in the dry season and the rainy season at Colon.*

	Midnight.	2 a	4 a	6 a	8 a	10 a	Noon.	2 p	4 p	6 p	8 p	10 p
Colon	−3	**6**	1	−12	*−21*	−8	36	**50**	28	−21	*−36*	−21

Here the differences have a semidiurnal period (double daily period). The maxima come at 2^h a. m. and 2^h p. m.; the minima come at 8^h a. m. and 8^h p. m. In the dry season the pressure is higher at 2^h p. m. than it is in the rainy season, lowest at 8^h p. m.; the afternoon minimum is weakened, as also the evening maximum. The forenoon extremes are also less pronounced. At Colon it is evident that it is not so much the rainy season as the prevailing winds that have the greatest influence on the daily march of the barometer. At Colon the sea winds—the north and northeast trades—blow exclusively during the dry season; during the rainy season the winds are more land winds from the south and southwest. On the other side of the divide, at Culebra and Ancon, the north and northeast winds are land winds and the southerly winds are sea winds. Evidently, the strong and very dominant sea or trade wind at Colon in winter

[5] The following check computation for Colon was made from the original figures (English inches):

January—March, $0.63 \sin (14.3°+x)+0.74 \sin (139.8°+2x)$.
April—June, $0.82 \sin (21.8°+x)+0.64 \sin (146.3°+2x)$.
July—September, $0\ 72 \sin (18.4°+x)+0.64 \sin (146.2°+2x)$.
September—December, $0.36 \sin (34.4°+x)+0.76 \sin (152.1°+2x)$.
Year, $0.63 \sin (21.4°+x)+0.69 \sin (146.4°+2x)$.

Here, as above, the amplitudes of the semidiurnal periods are certainly too small, and the same is true for the phase-angles of the semidiurnal periods at any rate near the beginning of the year.

is the wind that there outweighs the rainy season in influencing the daily barometric march. At Colon, in the dry season, 97 per cent of the winds are from the Atlantic Ocean, while in the rainy season these are but 22 per cent, and there are 50 per cent from the south, i. e., from the land. Hence the divergence. It is scarcely to be assumed that the small amplitude a_2 (only 0.67 mm.) is due to this circumstance. I regard this small value as improbable.

Finally, the intermediate (mean) ordinates of the daily barometric curve should be mentioned. Here, again, Colon probably has too small amplitudes, while for Alhajuela they probably are too large. But in this case we have 24 hourly observations, while the other three localities have but bihourly observations, whereby the daily march is somewhat flattened. (See Table 9.)

TABLE 9.—*Average ordinates of the curves of the daily march of pressure (maximum).*

	Ancon.	Culebra.	Alhajuela.	Colon.	Means.
January	0.659	0.752	0.748	0.527	0.671
February	0.650	0.777	0.885	0.539	0.713
March	**0.639**	**0.821**	**0.957**	**0.547**	**0.756**
April	0.673	0.780	0.772	0.545	0.693
May	0.544	0.597	*0.577*	0.508	0.557
June	0.479	0.624	0.639	0.452	0.548
July	*0.449*	*0.563*	0.621	*0.437*	*0.517*
August	0.547	0.617	0.677	0.498	0.585
September	0.609	0.648	**0.754**	0.582	0.648
October	0.644	0.638	0.720	**0.602**	**0.651**
November	**0.652**	0.687	0.663	0.533	0.646
December	0.626	0.727	0.748	0.618	0.680
Year	0.595	0.675	0.724	0.518	0.639

DAILY MARCH OF TEMPERATURE AND RELATIVE HUMIDITY.

I have computed the equations for the daily march of the temperature and the relative humidity for the extreme seasons, for the dry season, the rainy season, and for the year. In the following table these equations are grouped together. (See Tables 10, 11, and 12.)

Daily march of temperature.—In Ancon, Culebra, Colon, and Alhajuela [6] the temperature maximum occurs later in the dry season than it does in the rainy season, and the amplitudes are almost twice as great in the dry season as they are in the rainy season. Colon, however, is an exception to the latter rule, as its daily temperature range during its rainy season (October-November) is greater than during its dry season. The reason for this condition is to be sought in the wind conditions, which we have described above. The dry season has strong northerly sea winds (the trades), while the rainy season has southerly land winds. In Colon also, however, the rainy season has a lower average temperature than the dry season.

[6] Hann, Julius. Der tägliche Gang der Temperatur in den Tropen. I.—Das innere Tropengebiet. Denkschr., Kaiserl. Akad. d. Wissensch., Wien, Mathem.-naturw. Kl., 1905, 78: 284, 337.

TABLE 10.—*Daily march of temperature and humidity.*

ANCON (lat., 8° 57′ N.; long., 79° 33′ W.; alt., 28 m.)

(Departures from daily mean.)

Hours.	Dry season. Temperature.	Dry season. Relative humidity.	Rainy season. Temperature.	Rainy season. Relative humidity.	Year. Temperature.	Year. Relative humidity.
	°C.	Per cent.	°C.	Per cent.	°C.	Per cent.
Midnight	−3.3	13	−1.8	7	−2.4	9.3
2 a	−3.6	16	−2.2	7	−2.8	10.4
4 a	−4.1	17	−2.4	8	−3.2	10.8
6 a	*−4.2*	17	*−2.8*	7	*−3.4*	11.1
8 a	−1.3	13	−0.1	5	−0.7	7.9
10 a	3.0	− 3	2.8	− 5	2.7	− 3.8
Noon	5.2	−19	**3.9**	−13	**4.3**	−14.9
2 p	**5.7**	*−23*	3.1	*−14*	4.2	*−17.0*
4 p	4.9	−23	1.8	−10	3.0	−14.7
6 p	1.6	−17	0.2	− 4	0.9	− 8.6
8 p	−1.3	− 4	−0.8	3	−1.0	0.3
10 p	−2.5	9	−1.4	6	−1.9	7.1
Mean	3.4	14	1.9	7	2.5	9.7
Amplitude	9.9	40	6.7	21	7.7	28.1

EQUATIONS OF THE DIURNAL CURVES.

Dry season.

Temperature, $26.2+5.02 \sin (238.8°+x)+1.33 \sin (57.3°+2x)$.
Relative humidity, $73.5+20.6 \sin (42.1°+x)+5.2 \sin (205.9°+2x)$.

Rainy season.

Temperature, $25.0+2.76 \sin (242.6°+x)+1.10 \sin (91.6°+2x)$.
Relative humidity, $87.5+10.7 \sin (59.4°+x)+3.7 \sin (231.2°+2x)$.

Year.

Temperature, $25.8+3.77 \sin (242.0°+x)+1.10 \sin (76.2°+2x)$.
Relative humidity, $82.0+14.5 \sin (49.5°+x)+3.8 \sin (233.6°+2x)$.

TABLE 11.—*Daily march of temperature and humidity.*

CULEBRA (lat., 9° 3′ N.; long., 79° 39′ W.; alt., 123 m.)

(Departures from daily mean.)

Hours.	Dry season. Temperature.	Dry season. Relative humidity.	Rainy season. Temperature.	Rainy season. Relative humidity.	Year. Temperature.	Year. Relative humidity.
	°C.	Per cent.	°C.	Per cent.	°C.	Per cent.
Midnight	−2.7	14	−1.5	6	−1.9	9.4
2 a	−3.1	15	−1.8	7	−2.3	10.3
4 a	−3.5	17	−2.0	7	−2.6	10.7
6 a	*−3.8*	17	*−2.2*	7	*−2.8*	**11.0**
8 a	−1.4	13	−0.5	5	−1.0	8.7
10 a	2.6	− 2	2.3	− 3	2.5	− 2.5
Noon	4.4	−18	**3.6**	−13	**4.0**	−15.2
2 p	**4.9**	−23	2.7	*−14*	3.5	*−18.0*
4 p	3.7	−22	1.3	− 8	2.4	−14.1
6 p	1.4	−17	0.1	− 2	0.7	− 7.9
8 p	−1.0	− 1	−0.9	3	−0.9	1.2
10 p	−2.0	10	−1.1	6	−1.5	7.3
Mean	2.9	14	1.7	7	2.2	9.7
Amplitude	8.7	40	5.8	21	6.8	29.0

EQUATIONS OF THE DIURNAL CURVES.

Dry season.

Temperature, $25.0+4.71 \sin (229.8°+x)+1.15 \sin (62.4°+2x)$.
Relative humidity, $76.0+18.0 \sin (59.5°+x)+4.9 \sin (194.7°+2x)$.

Rainy season.

Temperature, $24.4+2.50 \sin (247.4°+x)+1.12 \sin (93.6°+2x)$.
Relative humidity, $89.3+9.1 \sin (70.8°+x)+4.0 \sin (226.8°+2x)$.

Year.

Temperature, $24.0+3.18 \sin (242.5°+x)+1.10 \sin (75.2°+2x)$.
Relative humidity, $84.0+14.4 \sin (49.5°+x)+4.4 \sin (211.4°+2x)$.

TABLE 12.—*Daily march of temperature and humidity.*

COLON (lat., 9° 22′ N.; long., 79° 54′ W.; alt., 3 m.)

(Departures from daily mean.)

Hours.	Dry season.		Rainy season.		Year.	
	Temperature.	Relative humidity.	Temperature.	Relative humidity.	Temperature.	Relative humidity.
	°C.	Per cent.	°C.	Per cent.	°C.	Per cent.
Midnight	−0.6	2.0	−1.1	3.0	−0.7	2.7
2 a.	−0.9	2.5	−1.5	4.5	−1.2	3.5
4 a.	−1.2	3.5	−1.7	4.5	−1.4	4.0
6 a.	*−1.3*	3.5	*−1.9*	4.5	*−1.6*	4.1
8 a.	−0.5	3.0	−0.4	3.0	−0.6	3.3
10 a.	0.7	−0.5	1.5	− 3.0	1.0	−1.1
Noon	1.4	−4.0	2.1	*− 7.5*	1.7	−5.1
2 p.	1.5	*−5.0*	2.0	− 6.5	1.6	*−5.8*
4 p.	1.3	−4.5	1.3	− 4.5	1.3	−4.3
6 p.	0.3	−2.5	0.6	− 1.5	0.4	−2.2
8 p.	−0.2	0.5	0.0	0.5	−0.1	0.3
10 p.	−0.4	2.0	0.0	2.5	−0.4	1.8
Mean	0.8	2.8	1.2	3.8	1.0	3.2
Amplitude	2.8	8.5	4.0	12.0	3.3	9.9

EQUATIONS OF THE DIURNAL CURVES.

Dry season.

Temperature, $26.4+1.10 \sin(248.6°+x)+0.46 \sin(69.6°+2x)$.
Relative humidity, $78.5+4.3 \sin(46.1°+x)+1.4 \sin(213.1°+2x)$.

Rainy season.

Temperature, $25.6+1.85 \sin(236.6°+x)+0.57 \sin(96.1°+2x)$.
Relative humidity, $88.0+5.6 \sin(56.3°+x)+2.0 \sin(252.4°+2x)$.

Year.

Temperature, $26.2+1.50 \sin(232.3°+x)+0.52 \sin(83.4°+2x)$.
Relative humidity, $84.0+4.7 \sin(47.6°+x)+1.5 \sin(228.2°+2x)$.

There is a great difference in the rainfalls, but the influence of the prevailing winds is dominant in Colon, a fact that is particularly striking in the case of the mean ordinates of the daily temperature curves.

TABLE 13.—*Illustrating influence of prevailing winds upon rainfalls and temperatures.*

	Ancon.	Culebra.	Alhajuela.	Colon.
Mean rainfalls (millimeters):				
February-March	42	31	37	79
October-November	467	605	705	918
Mean ordinates of temperature curves:				
February-March	3.4	2.9	3.2	0.8
October-November	1.9	1.7	1.8	1.2
Year	2.5	2.2	2.3	1.0

In spite of the extraordinary quantities of the rainfall during October and November (92 cm. as compared to only 8 cm. for February and March), the daily range of temperature at Colon for those months is greater by half than it is during the dry season.

TABLE 14.—*Differences between daily temperature marches in dry season versus rainy season (dry—rainy).*

	Midnight.	2a.	4a.	6a.	8a.	10a.	Noon.	2p.	4p.	6p.	8p.	10p.
Ancon	−1.5	−1.4	*−1.7*	−1.4	−1.2	0.2	1.3	2.6	3.1	1.4	−0.5	−1.1
Culebra	−1.2	−1.3	−1.4	*−1.6*	−0.9	0.3	0.9	2.2	2.4	1.3	−0.1	−0.9
Colon	0.5	0.6	0.6	0.6	−0.1	*−0.8*	−0.7	−0.5	0.0	−0.3	−0.2	0.2

The night hours are at least relatively cooler and the daytime hours relatively warmer during the dry season; the maximum positive temperature difference does not occur until 4h p. m. This is true for Ancon and Culebra, but it is different at Colon, where the march of the considerably smaller differences is just the reverse.

Daily march of relative humidity.—The daily march of the relative humidity is just the reverse of that of the temperature, as is shown with special clearness by the equations of the daily march. The phase-angle A_1 as well the less regular A_2 for the relative humidity, differs by about 180° from those for the temperature. The minimum relative humidity occurs with the maximum temperature, and conversely the maximum humidity occurs at the time of the minimum temperature. The daily amplitude of the relative humidity is, except at Colon, three times as great in the dry season as it is in the rainy season. The minimum occurs about an hour earlier during the rainy season than it does during the dry season (dry season about 50°, rainy season about 65°); while at Colon the difference between the two seasons is somewhat smaller (46° as against 56°).

The relation between temperature amplitude and relative humidity amplitude is quite constant. If we designate the daily amplitude of the relative humidity by aF, and the daily amplitude of the temperature by at, their comparison gives the following quotients:

TABLE 15.—*Ratio of daily amplitudes of relative humidity and temperature.*

Station.	$a_1F : a_1t$.			$a_2F : a_2t$.		
	Dry.	Rainy.	Year.	Dry.	Rainy.	Year.
Ancon	4.1	3.8	3.8	3.9	3.4	3.5
Culebra	3.8	3.6	4.5	4.1	3.6	4.0
Colon	4.3	3.0	3.1	3.0	2.9	3.0
Mean	4.1	3.5	3.8	3.7	3.3	3.5

Taking the average diurnal variation in the relative humidity as a whole, a periodic temperature change of +1° C. corresponds to a change of −3.8 per cent in the relative humidity; in the average semidiurnal variation a periodic temperature change of +1.0°C. corresponds to a change of −3.5°C. in the relative humidity, or almost the same amount. One may say, then, that in their daily marches a temperature change of +10°C. corresponds to a change of about −36 per cent in the relative humidity. This relation between temperature change and humidity change is a strikingly constant one. It is but little less marked during the rainy season than during the dry season, and Colon also is no exception in this case.

TABLE 16.—*Daily march of pressure at Alhajuela, Canal Zone, 1900–1904.**

(Departures from the monthly means.)

Hour.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Hour.
A. M.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	A. M.
1	0.51	0.70	0.85	0.62	0.35	0.56	0.59	0.56	0.57	0.46	0.35	0.57	0.557	1.
2	0.34	0.50	0.63	0.40	0.13	0.33	0.32	0.29	0.26	0.20	0.08	0.36	0.320	2.
3	*0.19*	*0.37*	0.46	0.21	*0.08*	0.19	0.17	0.14	*0.11*	*0.04*	*−0.08*	*0.19*	*0.168*	3.
4	0.21	0.37	*0.39*	*0.24*	0.06	*0.16*	*0.08*	*0.12*	0.15	0.11	0.00	0.21	0.175	4.
5	0.37	0.53	0.53	0.36	0.20	0.31	0.18	0.30	0.31	0.27	0.18	0.40	0.328	5.
6	0.66	0.80	0.83	0.64	0.53	0.56	0.37	0.55	0.62	0.60	0.49	0.66	0.609	6.
7	1.02	1.16	1.16	0.95	0.81	0.85	0.71	0.82	0.91	0.91	0.87	0.97	0.928	7.
8	**1.16**	**1.35**	**1.39**	1.15	**0.88**	**0.91**	**0.82**	**0.98**	**1.18**	**1.10**	1.08	**1.16**	**1.097**	8.
9	0.99	1.19	1.27	**1.21**	0.78	0.76	0.73	0.81	1.12	1.07	**1.09**	1.00	1.002	9.
10	0.57	0.83	0.90	0.67	0.52	0.40	0.49	0.45	0.71	0.70	0.52	0.61	0.614	10.
11	0.06	0.24	0.31	0.26	0.14	−0.12	0.07	−0.03	0.09	0.27	0.09	0.07	0.121	11.
Noon	−0.46	−0.41	−0.28	−0.19	−0.27	−0.50	−0.31	−0.52	−0.53	−0.54	−0.50	−0.47	−0.415	Noon.
P. M.														P. M.
1	−1.01	−0.88	−0.90	−0.73	−0.72	−0.86	−0.74	−0.94	−1.08	−1.05	−0.99	−1.02	−0.910	1.
2	−1.49	−1.49	−1.55	−1.29	−1.07	−1.14	−1.11	−1.28	−1.52	−1.42	−1.39	−1.48	−1.352	2.
3	*−1.67*	−1.90	−1.99	−1.61	−1.30	−1.36	−1.34	−1.47	*−1.71*	*−1.63*	*−1.52*	*−1.67*	*−1.597*	3.
4	−1.64	*−1.96*	*−2.09*	*−1.75*	*−1.32*	*−1.37*	*−1.38*	*−1.50*	−1.59	−1.53	−1.42	−1.60	*−1.596*	4.
5	−1.36	−1.76	−1.94	−1.63	−1.17	−1.18	−1.24	−1.25	−1.35	−1.26	−1.17	−1.40	−1.392	5.
6	−0.90	−1.24	−1.51	−1.25	−0.77	−0.80	−0.88	−0.83	−0.89	−0.87	−0.71	−0.90	−0.962	6.
7	−0.39	−0.73	−0.92	−0.68	−0.33	−0.32	−0.40	−0.35	−0.41	−0.38	−0.23	−0.42	−0.463	7.
8	0.13	−0.20	−0.31	−0.18	0.10	0.08	0.07	0.13	0.07	0.11	0.22	0.11	0.027	8.
9	0.51	0.28	0.15	0.28	0.42	0.42	0.47	0.48	0.50	0.51	0.65	0.48	0.429	9.
10	0.77	0.65	0.67	0.62	0.64	0.65	0.75	0.81	0.77	0.74	**0.84**	0.71	0.718	10.
11	**0.82**	**0.85**	0.94	**0.82**	**0.73**	**0.76**	**0.86**	**0.86**	**0.89**	**0.83**	0.80	**0.78**	**0.828**	11.
12	−0.73	0.85	**1.01**	0.79	0.58	0.75	0.83	0.79	0.76	0.68	0.64	0.71	0.759	12.
Mean	0.748	0.885	0.957	0.772	0.577	0.639	0.621	0.677	0.754	0.720	0.663	0.748	0.724	Mean.
Monthly mean.	759.75	759.72	759.41	758.78	759.51	759.33	759.65	759.69	759.98	760.03	759.82	759.55	759.60	Monthly mean.

* See the opening paragraphs of this paper and footnote 2.

TABLE 17.—*Daily march of pressure at Ancon, Canal Zone.*

(Departures from the monthly means.)

Hour.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Hour.
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	
Midnight	0.63	0.61	0.63	0.58	0.32	0.50	0.46	0.54	0.48	0.42	0.37	0.40	0.495	Midnight.
2^{a}	−0.14	0.00	0.04	−0.06	−0.27	−0.19	−0.05	−0.14	−0.20	−0.39	−0.39	−0.26	−0.171	2^{a}.
4^{a}	−0.21	−0.20	−0.08	−0.19	−0.39	−0.36	−0.25	−0.27	−0.46	−0.47	−0.56	−0.41	−0.321	4^{a}.
6^{a}	0.17	0.24	0.33	0.32	0.06	0.01	0.02	0.08	0.10	0.11	0.07	0.15	0.138	6^{a}.
8^{a}	1.06	1.07	1.09	0.98	0.88	0.71	0.64	0.74	0.93	1.01	1.01	1.11	0.936	8^{a}.
10^{a}	1.13	1.25	1.21	1.08	1.00	0.83	0.77	0.93	1.12	1.18	1.27	1.11	1.073	10^{a}.
Noon	0.22	0.36	0.19	0.35	0.37	0.32	0.21	0.37	0.42	0.29	0.25	0.20	0.296	Noon.
2^{p}	−1.10	−0.96	−1.15	−1.00	−0.57	−0.41	−0.55	−0.65	−0.74	−0.90	−0.90	−0.97	−0.825	2^{p}.
4^{p}	−1.53	−1.52	−1.71	−1.63	−1.21	−1.12	−1.11	−1.24	−1.25	−1.36	−1.27	−1.32	−1.356	4^{p}.
6^{p}	−0.97	−1.08	−1.20	−1.07	−0.83	−0.77	−0.74	−0.90	−0.92	−0.77	−0.77	−0.77	−0.899	6^{p}.
8^{p}	0.12	−0.12	−0.08	−0.11	0.06	−0.01	0.00	−0.09	−0.08	0.16	0.20	0.10	0.012	8^{p}.
10^{p}	0.63	0.39	0.68	0.71	0.57	0.52	0.59	0.62	0.61	0.67	0.76	0.71	0.622	10^{p}.
Mean	0.659	0.650	0.699	0.673	0.544	0.479	0.449	0.547	0.609	0.644	0.652	0.626	0.595	Mean.

TABLE 18.—*Daily march of pressure at Culebra, Canal Zone.*

(Departures from monthly means.)

Hour.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Hour.
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	
Midnight	0.77	0.76	0.85	0.84	0.68	0.73	0.80	0.80	0.73	0.57	0.71	0.65	0.741	Midnight.
2^{a}	0.11	0.25	0.29	0.28	0.10	0.32	0.29	0.24	0.14	0.11	−0.10	0.09	0.177	2^{a}.
4^{a}	−0.14	−0.10	0.03	−0.07	−0.08	−0.14	−0.06	−0.22	−0.28	−0.32	−0.30	−0.29	−0.164	4^{a}.
6^{a}	0.21	0.20	0.44	0.23	0.07	0.17	0.04	0.04	0.07	0.06	0.07	0.09	0.141	6^{a}.
8^{a}	1.13	1.11	1.05	1.20	0.73	0.73	0.65	0.60	0.79	1.00	0.97	1.03	0.916	8^{a}.
10^{a}	1.38	1.42	1.36	1.25	0.98	0.98	0.75	1.00	1.09	1.25	1.27	1.41	1.178	10^{a}.
Noon	0.21	0.25	0.19	0.18	0.30	0.27	0.09	0.34	0.43	0.19	0.20	0.09	0.228	Noon.
2^{p}	−1.16	−1.17	−1.24	−1.09	−0.84	−0.74	−0.82	−0.83	−0.84	−1.03	−1.07	−1.26	−1.007	2^{p}.
4^{p}	−1.82	−1.88	−2.05	−1.85	−1.43	−1.34	−1.39	−1.44	−1.50	−1.54	−1.57	−1.77	−1.632	4^{p}.
6^{p}	−1.37	−1.48	−1.64	−1.65	−1.22	−1.10	−1.08	−1.08	−1.20	−0.96	−1.07	−1.06	−1.243	6^{p}.
8^{p}	0.11	−0.05	−0.02	−0.02	0.17	−0.39	0.09	−0.12	−0.08	0.06	0.20	0.21	0.013	8^{p}.
10^{p}	0.62	0.66	0.69	0.70	0.56	0.58	0.70	0.70	0.63	0.57	0.71	0.77	0.657	10^{p}.
Mean	0.752	0.777	0.821	0.780	0.597	0.624	0.563	0.617	0.648	0.638	0.687	0.727	0.675	Mean.

TABLE 19.—*Daily march of pressure at Colon, Canal Zone.*

(Departures from monthly means.)

Hour.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Hour.
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	
Midnight	0.52	0.46	0.57	0.58	0.55	0.58	0.58	0.57	0.59	0.56	0.55	0.48	0.549	Midnight.
2a	−0.14	0.20	0.13	0.19	0.35	0.20	0.18	0.21	0.26	0.15	0.04	0.05	0.152	2a.
4a	−0.26	−0.13	−0.20	−0.16	−0.03	0.07	0.00	−0.04	−0.05	−0.17	−0.20	−0.26	−0.119	4a.
6a	−0.06	−0.10	−0.07	−0.03	0.05	0.07	−0.13	−0.09	0.03	0.05	0.04	−0.08	−0.027	6a.
8a	0.65	0.63	0.69	0.70	0.68	0.63	0.50	0.60	0.80	0.86	0.88	0.81	0.702	8a.
10a	1.03	1.01	0.99	0.96	0.81	0.50	0.68	0.75	0.97	1.11	1.06	1.01	0.907	10a.
Noon	0.45	0.53	0.52	0.48	0.18	0.25	0.25	0.29	0.34	0.20	0.12	0.35	0.330	Noon.
2p	−0.57	−0.44	−0.50	−0.54	−0.72	−0.64	−0.51	−0.60	−0.81	−0.97	−0.97	−0.71	−0.665	2p.
4p	−1.08	−1.12	−1.16	−1.25	−1.30	−1.13	−1.07	−1.21	−1.39	−1.48	−1.36	−1.22	−1.231	4p.
6p	−1.03	−1.20	−1.16	−1.13	−0.97	−0.94	−0.89	−1.03	−1.19	−0.97	−0.97	−0.97	−1.037	6p.
8p	0.01	−0.24	−0.20	−0.18	−0.03	0.02	0.08	−0.04	−0.05	0.10	0.17	0.00	−0.030	8p.
10p	0.52	0.41	0.38	0.34	0.43	0.40	0.38	0.55	0.51	0.60	0.63	0.48	0.470	10p.
Mean	0.527	0.539	0.547	0.545	0.508	0.452	0.437	0.498	0.582	0.602	0.583	0.618	0.518	Mean.

TABLE 20.—*Daily march of temperature at Ancon, Canal Zone.*

(Departure from monthly means.)

Hour.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Hour.
	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	
2a	−3.3	−3.6	−3.7	−3.4	−2.5	−2.3	−2.5	−2.6	−2.5	−2.0	−2.3	−2.9	−2.8	2a.
4a	−3.6	−3.8	−4.3	−3.7	−3.0	−2.6	−2.7	−2.9	−2.9	−2.4	−2.4	−3.2	−3.2	4a.
6a	−3.9	−4.1	−4.3	−3.8	−3.3	−2.6	−3.0	−3.1	−3.0	−2.9	−2.7	−3.5	−3.4	6a.
8a	−1.5	−1.6	−1.2	−0.5	−0.1	−0.4	−0.4	−0.4	−0.5	−0.1	−0.1	−1.1	−0.7	8a.
10a	3.0	3.0	3.0	3.0	3.0	2.4	2.4	2.5	2.4	2.9	2.7	2.8	2.7	10a.
Noon	5.1	5.0	5.4	4.7	3.8	3.5	3.8	3.9	3.6	4.0	3.8	4.8	4.3	Noon.
2p	5.5	5.6	5.9	4.7	3.3	3.3	3.5	3.5	3.5	3.0	3.2	4.3	4.1	2p.
4p	4.5	4.8	5.0	3.7	2.3	2.1	2.4	2.4	2.4	1.7	2.0	3.5	3.0	4p.
6p	1.2	1.5	1.8	1.3	0.8	0.6	0.7	0.7	0.8	0.2	0.2	0.8	0.9	6p.
8p	−1.4	−1.3	−1.4	−1.2	−0.8	−0.5	−0.7	−0.9	−0.7	−0.8	−0.9	−1.2	−1.0	8p.
10p	−2.4	−2.5	−2.5	−2.3	−1.6	−1.4	−1.6	−1.5	−1.5	−1.5	−1.3	−2.1	−1.9	10p.
12p	−3.0	−3.2	−3.3	−2.8	−2.2	−1.9	−2.1	−2.1	−2.0	−1.8	−1.7	−2.4	−2.4	12p.
Means	2.20	3.33	3.48	2.92	2.22	1.97	2.15	2.21	2.15	1.94	1.94	2.72	2.53	Mean.

TABLE 21.—*Daily march of temperature at Culebra, Canal Zone.*

(Departure from monthly means.)

Hour.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Hour.
	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	
2a	−2.6	−2.9	−3.3	−3.0	−2.4	−1.5	−2.1	−2.0	−2.1	−2.0	−1.6	−2.1	−2.3	2a.
4a	−3.2	−3.2	−3.6	−3.4	−2.4	−2.4	−2.2	−2.2	−2.2	−2.2	−1.9	−2.5	−2.6	4a.
6a	−3.2	−3.6	−3.9	−3.6	−2.8	−2.6	−2.2	−2.4	−2.5	−2.3	−2.1	−2.7	−2.8	6a.
8a	−1.7	−1.7	−1.2	−0.5	−0.6	−1.0	−0.9	−0.8	−0.6	−0.5	−0.5	−1.8	−1.0	8a.
10a	2.4	2.3	2.9	3.0	3.3	2.1	2.1	2.2	2.7	2.4	2.2	2.2	2.5	10a.
Noon	4.1	4.3	4.7	4.5	4.0	3.7	3.8	3.8	3.9	3.7	3.4	4.0	4.0	Noon.
2p	4.4	4.8	5.0	4.3	3.0	3.1	3.0	3.2	3.3	2.8	2.6	3.7	3.5	2p.
4p	3.6	3.5	3.9	3.1	1.6	1.7	1.9	1.8	1.7	1.3	1.4	2.7	2.4	4p.
6p	1.3	1.4	1.4	1.0	0.4	0.4	0.7	0.6	0.4	0.1	0.1	0.8	0.7	6p.
8p	0.9	−1.0	−1.0	−1.1	−1.0	−1.0	−0.9	−0.8	−0.9	−0.9	−0.9	−0.9	−0.9	8p.
10p	−1.8	−1.9	−2.1	−1.8	−1.6	−1.4	−1.3	−1.3	−1.5	−1.2	−1.1	−1.5	−1.5	10p.
12p	−2.5	−2.5	−2.8	−2.1	−1.7	−1.5	−1.5	−1.7	−1.7	−1.6	−1.3	−1.8	−1.9	12p.
Mean	2.64	2.76	2.98	2.62	2.07	1.87	1.88	1.90	1.96	1.75	1.59	2.22	2.17	Mean.

TABLE 22.—*Daily march of temperature at Colon, Canal Zone.*

(Departure from monthly means.)

Hour.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Hour.
	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	
2a	−0.9	−0.8	−1.0	−1.2	−1.1	−1.4	−1.0	−1.2	−1.4	−1.6	−1.4	−0.9	−1.2	2a.
4a	−1.2	−1.1	−1.2	−1.3	−1.4	−1.8	−1.6	−1.3	−1.7	−1.9	−1.5	−1.2	−1.4	4a.
6a	−1.2	−1.2	−1.4	−1.3	−1.8	−2.0	−1.6	−1.9	−2.0	−2.1	−1.7	−1.5	−1.6	6a.
8a	−0.6	−0.5	−0.6	−0.5	−0.6	−0.6	−0.6	−0.9	−0.6	−0.3	−0.6	−0.5	−0.6	8a.
10a	0.8	0.6	0.8	0.9	1.1	1.1	0.9	0.9	1.5	1.8	1.2	0.7	1.0	10a.
Noon	1.4	1.4	1.5	1.6	2.0	2.0	1.7	1.6	2.2	2.5	1.6	1.5	1.7	Noon.
2p	1.6	1.4	1.5	1.5	1.7	1.7	1.5	1.4	1.9	2.2	1.8	1.6	1.6	2p.
4p	1.2	1.3	1.3	1.3	1.4	1.2	1.1	1.1	1.5	1.4	1.2	1.1	1.3	4p.
6p	0.1	0.4	0.2	0.4	0.4	0.7	0.5	0.6	0.6	0.6	0.5	0.3	0.4	6p.
8p	−0.1	−0.2	−0.3	−0.1	−0.2	0.1	0.0	1.1	0.0	−0.2	0.2	0.1	−0.1	8p.
10p	−0.5	−0.2	−0.6	−0.5	−0.6	−0.4	−0.2	−0.3	−0.5	−0.8	−0.3	−0.2	−0.4	10p.
12p	−0.6	−0.5	−0.7	−0.6	−0.7	−0.8	−0.5	−0.6	−0.9	−1.2	−0.9	−0.5	−0.7	12p.
Mean	0.85	0.80	0.92	0.93	1.08	1.15	0.93	0.99	1.23	1.38	1.07	0.84	1.00	Mean.

TABLE 23.—*Daily march of relative humidity at Ancon, Canal Zone.*

(Departures from monthly means.)

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2a	14	15	16	13	9	8	8	9	8	7	7	11	10.4
4a	15	16	17	14	10	8	8	9	8	7	7	11	10.8
6a	15	16	18	15	10	8	9	9	8	7	7	11	11.1
8a	12	13	14	9	6	5	6	6	5	5	5	9	7.9
10a	− 3	− 3	− 3	− 6	− 5	− 3	− 4	− 3	− 4	− 5	− 4	− 3	− 3.8
Noon	−18	−19	−19	−16	−13	−11	−13	−13	−13	−14	−13	−17	−14.9
2p	−23	−23	−24	−19	−13	−12	−15	−15	−14	−14	−14	−18	−17.0
4p	−22	−22	−24	−18	−10	− 9	−12	−12	−12	−10	−10	−16	−14.7
6p	−15	−16	−18	−13	− 5	− 5	− 6	− 6	− 2	− 4	− 4	− 9	− 8.6
8p	0	− 3	− 4	− 2	1	1	1	1	1	3	3	1	0.3
10p	9	9	9	7	6	6	6	7	5	7	6	8	7.1
12p	13	13	14	11	8	7	7	8	7	7	7	10	9.3
Mean	13	14	15	12	8	7	8	8	7	7	7	10	9.7

TABLE 24.—*Daily march of relative humidity at Culebra, Canal Zone.*

(Departures from monthly means.)

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2a	13	14	17	15	9	8	9	8	8	7	7	9	10.3
4a	14	15	18	15	10	8	9	8	8	7	7	10	10.7
6a	14	16	18	16	10	8	9	8	8	7	7	10	11.0
8a	13	13	14	11	7	7	7	7	6	5	5	9	8.7
10a	− 1	− 1	− 3	− 5	− 4	− 1	− 2	− 2	− 4	− 4	− 2	− 1	− 2.5
Noon	−16	−17	−19	−18	−16	−13	−13	−14	−14	−15	−12	−15	−15.2
2p	−21	−23	−24	−21	−16	−16	−16	−17	−16	−15	−12	−19	−18.0
4p	−21	−21	−22	−18	−10	−11	−11	−11	−11	− 9	− 8	−16	−14.1
6p	−14	−15	−18	−12	− 4	− 5	− 5	− 4	− 5	− 2	− 2	− 9	− 7.9
8p	0	− 1	− 2	0	3	2	− 1	2	3	3	4	2	1.2
10p	9	8	11	9	7	6	7	6	6	6	6	7	7.3
12p	12	13	14	13	9	7	8	8	7	7	6	9	9.4
Mean	12	13	15	13	9	8	8	8	8	7	7	10	9.7

TABLE 25.—*Daily march of relative humidity at Colon, Canal Zone.*

(Departures from monthly means.)

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2a	3	2	3	3	3	4	3	4	5	5	4	3	3.5
4a	3	3	4	4	4	5	4	4	5	5	4	3	4.0
6a	4	3	4	4	4	5	4	4	5	5	4	3	4.1
8a	3	3	4	3	3	4	3	4	4	3	3	3	3.3
10a	0	0	−1	−1	−1	0	−1	−1	− 2	− 4	−2	0	−1.1
Noon	−4	−4	−4	−5	−4	−6	−4	−5	− 7	−10	−5	−3	−5.1
2p	−5	−5	−5	−5	−4	−7	−6	−5	−10	− 8	−5	−5	−5.8
4p	−5	−5	−4	−5	−3	−5	−4	−3	− 5	− 5	−4	−4	−4.3
6p	−2	−3	−2	−3	−2	−3	−2	−2	− 3	− 2	−1	−2	−2.2
8p	1	0	1	0	1	0	0	0	0	1	0	0	0.3
10p	2	1	3	2	2	1	1	2	2	3	2	1	1.8
12p	2	2	3	2	3	3	3	3	4	3	3	2	2.7
Mean	3	3	3	3	3	4	3	3	4	4	3	2	3.2

TABLE 26.—*Average hourly temperature at Ancon, Canal Zone.*

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
2a	22.4	22.3	22.7	23.2	23.4	23.5	23.3	23.2	23.3	23.2	22.6	22.6	23.0
4a	22.1	22.1	22.1	22.9	22.9	23.2	23.1	22.9	22.9	22.8	22.5	22.3	22.6
6a	21.8	21.8	22.1	22.8	22.6	23.2	22.8	22.7	22.8	22.3	22.2	22.0	22.4
8a	24.2	24.3	25.2	26.1	25.8	25.4	25.4	25.4	25.3	25.1	24.8	24.4	25.1
10a	28.7	28.9	29.4	29.6	28.9	28.2	28.2	28.3	28.2	28.1	27.6	28.3	28.5
Noon	30.8	30.9	31.8	31.3	29.7	29.3	29.6	29.7	29.4	29.2	28.7	30.3	30.1
2p	31.2	31.5	32.3	31.3	29.2	29.1	29.3	29.3	29.3	28.2	28.1	29.8	29.9
4p	30.2	30.7	31.4	30.3	28.2	27.9	28.2	28.2	28.2	26.9	26.9	29.0	28.8
6p	26.9	27.4	28.2	27.9	26.7	26.4	26.5	26.5	26.6	25.4	25.1	26.3	26.7
8p	24.3	24.6	25.0	25.4	25.1	25.3	25.1	24.9	25.1	24.4	24.0	24.3	24.8
10p	23.3	23.4	23.9	24.3	24.3	24.4	24.2	24.3	24.3	23.7	23.6	23.4	23.9
12p	22.7	22.7	23.1	23.8	23.7	23.9	23.7	23.7	23.8	23.4	23.2	23.1	23.4
Mean	25.7	25.9	26.4	26.6	25.9	25.8	25.8	25.8	25.8	25.2	24.9	25.5	25.8

TABLE 27.—*Average hourly temperature at Culebra, Canal Zone.*

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
2a	22.0	21.9	21.9	22.7	22.9	23.7	23.0	23.0	22.8	22.5	22.6	22.5	22.6
4a	21.4	21.6	21.6	22.3	22.9	22.8	22.9	22.8	22.7	22.3	22.3	22.1	22.3
6a	21.4	21.2	21.3	22.1	22.5	22.6	22.9	22.6	22.4	22.2	22.1	21.9	22.1
8a	22.9	23.1	24.0	25.2	24.7	24.2	24.2	24.2	24.3	24.0	23.7	22.8	23.9
10a	27.0	27.1	28.1	28.7	28.6	27.3	27.2	27.2	27.6	26.9	26.4	26.8	27.4
Noon	28.7	29.1	29.9	30.2	29.3	28.9	28.9	28.8	28.8	28.2	27.6	28.6	28.9
2p	29.0	29.6	30.2	30.0	28.3	28.3	28.1	28.2	28.2	27.3	26.8	28.3	28.4
4p	28.2	28.3	29.1	28.8	26.9	26.9	27.0	26.8	26.6	25.8	25.6	27.3	27.3
6p	25.9	26.2	26.6	26.7	25.7	25.6	25.8	25.6	25.3	24.6	24.3	25.4	25.6
8p	23.7	23.8	24.2	24.6	24.3	24.2	24.2	24.2	24.0	23.6	23.3	23.7	24.0
10p	22.8	22.9	23.1	23.9	23.7	23.8	23.8	23.7	23.4	23.3	23.1	23.1	23.4
12p	22.1	22.3	22.4	23.6	23.6	23.7	23.6	23.3	23.2	22.9	22.9	22.8	23.0
Mean	24.6	24.8	25.2	25.7	25.3	25.2	25.1	25.0	24.9	24.5	24.2	24.6	24.9

TABLE 28.—*Average hourly temperature at Colon, Canal Zone.*

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
2a	25.4	25.4	25.6	25.7	25.3	24.8	25.2	25.0	24.7	23.9	24.3	25.2	25.0
4a	25.1	25.1	25.4	25.6	25.0	24.4	24.6	24.9	24.4	23.6	24.2	24.9	24.8
6a	25.1	25.0	25.2	25.6	24.6	24.2	24.6	24.5	24.1	23.4	24.0	24.6	24.6
8a	25.7	25.7	26.0	26.4	25.8	25.6	25.6	25.3	25.5	25.2	25.1	25.6	25.6
10a	27.1	26.8	27.4	27.8	27.5	27.3	27.1	27.1	27.6	27.3	26.9	26.8	27.2
Noon	27.6	27.6	28.1	28.5	28.4	28.2	27.9	27.8	28.3	28.0	27.3	27.6	27.9
2p	27.9	27.6	28.1	28.4	28.1	27.9	27.7	27.6	28.0	27.7	27.5	27.7	27.8
4p	27.5	27.5	27.9	28.2	27.8	27.4	27.3	27.3	27.6	26.9	26.9	27.2	27.5
6p	26.4	26.6	26.8	27.3	26.8	26.9	26.7	26.8	26.7	26.1	26.2	26.4	26.6
8p	26.2	26.2	26.3	26.8	26.2	26.3	26.2	26.3	26.1	25.3	25.9	26.2	26.1
10p	25.8	26.0	26.0	26.4	25.8	25.8	26.0	25.9	25.6	24.7	25.4	25.9	25.8
12p	25.7	25.7	25.9	26.3	25.7	25.4	25.7	25.6	25.2	24.3	24.8	25.6	25.5
Mean	26.3	26.2	26.6	26.6	26.4	26.2	26.2	26.2	26.1	25.5	25.7	26.1	26.2

TABLE 29.—*Average hourly relative humidity at Ancon, Canal Zone.*

(6 years.)

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2a	91	90	88	90	94	94	94	95	95	94	95	94	93
4a	92	91	89	91	95	94	94	95	95	94	95	94	93
6a	92	91	90	92	95	94	95	95	95	94	95	94	93
8a	89	88	86	86	91	91	92	92	92	92	93	92	90
10a	74	72	69	71	80	83	82	83	83	82	84	80	79
Noon	59	56	53	61	72	75	73	73	74	73	75	66	67
2p	54	52	48	58	72	74	71	71	73	73	74	65	65
4p	55	53	48	59	75	77	74	74	75	77	78	67	68
6p	62	59	54	64	80	81	80	80	85	83	84	74	74
8p	77	72	68	75	86	87	87	87	88	90	91	84	83
10p	86	84	81	84	91	92	92	93	92	94	94	91	89
12p	90	88	86	88	93	93	93	94	94	94	95	93	92
Mean	77	75	72	77	85	86	86	86	87	87	88	83	82

TABLE 30.—*Average hourly relative humidity at Culebra, Canal Zone.*

(4-5 years.)

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2a	92	92	91	93	94	96	96	96	96	96	96	94	94
4a	93	93	92	93	95	96	96	96	96	96	96	95	95
6a	93	94	92	94	95	96	96	96	96	96	96	95	95
8a	92	91	88	89	92	95	94	95	94	94	94	94	93
10a	78	77	71	73	81	87	85	86	84	85	87	84	81
Noon	63	61	55	60	69	75	74	74	74	74	77	70	69
2p	58	55	50	57	69	72	71	71	72	74	77	66	66
4p	58	57	52	60	75	77	76	77	77	80	81	69	70
6p	65	63	56	66	81	83	82	84	83	87	87	76	76
8p	79	77	72	78	88	90	86	90	91	92	93	87	85
10p	88	86	85	87	92	94	94	94	94	95	95	92	91
12p	91	91	88	91	94	95	95	96	95	96	95	94	93
Mean	79	78	74	78	85	88	87	88	88	89	89.5	85	84

TABLE 31.—*Average hourly relative humidity at Colon, Canal Zone.*

(5-7 years.)

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2a	83	82	80	83	88	91	90	91	92	93	92	88	88
4a	83	83	81	84	89	92	91	91	92	93	92	88	88
6a	84	83	81	84	89	92	91	91	92	93	92	88	88
8a	83	83	81	83	88	91	90	91	91	91	91	88	88
10a	80	80	76	79	84	87	86	86	85	84	86	85	83
Noon	76	76	73	75	81	81	83	82	80	78	83	82	79
2p	75	75	72	75	81	80	81	82	77	80	83	80	78
4p	75	75	73	75	82	82	83	84	82	83	84	81	80
6p	78	77	75	77	83	84	85	85	84	86	87	83	82
8p	81	80	78	80	86	87	87	87	87	89	88	85	85
10p	82	81	80	82	87	88	88	89	89	91	90	86	86
12p	82	82	80	82	88	90	90	90	91	91	91	87	87
Mean	80	80	77	80	85	87	87	87	87	88	88	85	84

THE FUNCTION OF THE ATMOSPHERE IN [WIRELESS] TRANSMISSION.[1]

By J. ERSKINE-MURRAY, Sc. D.

[Dr. James Erskine-Murray was born in Edinburgh on October 24, 1868, and after a course of six years' study under the late Lord Kelvin at Glasgow University he entered Trinity College, Cambridge, as a research student. In 1898 he was appointed experimental assistant to Mr. Marconi. In 1900 he took up the post of lecturer and demonstrator in physics and electrical engineering at the University College, Nottingham, and in 1905 he was appointed to the lectureship in electrical engineering at the George Coates' Technical College, Paisley. In 1905 he took up consulting work in radiotelegraphy.

[The following paper is reprinted by permission of the editor of the Yearbook, Mr. Arthur Cohen.]

An interesting article by Dr. Eccles on certain aspects of transmission through the atmosphere appeared in the Yearbook [of wireless telegraphy] for 1913, the treatment of the subject being mainly from the point of view of his own and other physical theories for the explanation of "freak" transmissions. In the following pages I have attempted to analyze typical cases of unusual wireless transmission and to deduce from these in conjunction with the known and fundamental physical facts of the case a true idea of the function of the atmosphere in transmission without the use of any explanatory hypotheses.

That the atmosphere ought to have some slight influence on the transmission of electric or "ether" waves from place to place on the earth's surface is obvious when one recollects that the air, though a very good insulator at pressures such as exist at the earth's surface, is nowhere a perfect insulator and has quite different electrical qualities at the low pressures which occur at heights above 30 or 40 miles to those it possesses at lower elevations.

Electrical waves must necessarily have a good insulator to pass through; they are guided by a conductor, but do not pass through it, only diffusing slowly into it and being dissipated as heat in the conducting material. The better the conductor the smaller is the depth of penetration of the waves into it and the less the loss of energy on this account. At the same time every conductor, whether a wire or a great mass like the earth, does conduct—that is to say, the electrical disturbance follows and is guided by its surface.

In Hertz's experiments and in Mr. Marconi's earliest form of apparatus true radiation took place, i. e., there was a free and unguided passage of an electric disturbance from one conductor to another conductor through an insulating medium, the air, in which both were situated.

In modern wireless telegraphy free radiation does not take place when the stations are situated on land or sea, for the receiver is actually in direct connection with the earth and the latter forms part of the transmitter. Modern wireless is thus merely transmission from one part of a conductor to another part of the same. No return circuit such as is used in ordinary telegraphy is needed, because the disturbance is not continuous but alternating, and is of comparatively small wave length. I may quote from the 1907 edition of my handbook[2] a definition which puts the matter succinctly; it is as follows:

> Reduced to its simplest terms, the modern wireless telegraph is a large conducting sphere (the earth) with two conducting excrescences on it or near its surface (the aerial conductors). In one of these a sudden oscillatory movement of electricity is started, which spreads over the surface, causing to-and-fro currents in the other wire is it passes.

It will be understood, therefore, that as these have been my views since 1898, I was not one of those whom Dr. Eccles in his article in last year's Yearbook speaks of as being surprised at Mr. Marconi's success in trans-Atlantic transmission round the curve of the world.

If the lower atmosphere were as conductive as the sea is, wireless telegraphy from place to place on the earth's surface would be impossible, for the electric waves would not penetrate such a material to more than a few yards from the transmitter. Thus wireless telegraphy between completely submerged submarines is impracticable. The same is true in regard to wireless transmission in mines. Where the rocks are dry and insulating, transmission is possible through them up to a mile or two; but where they are wet and therefore conducting, wireless telegraphy is impracticable. The nonconducting layer of air in contact with the ground and rising to some 30 miles above it is thus the stratum through which the electric waves can pass in traveling from station to station. Above lies the less dense air which is certainly not a good insulator and therefore must either absorb or reflect the waves which come up to it from the transmitter. There is now experimental evidence that at night this upper layer does reflect the waves down again, and thus signals are received at greater distances than in the daytime; and Dr. [L. W.] Austin is of opinion that even in the daytime the action is not always absorption only, but that occasionally there is a slight strengthening of the signals by reflection.

The first suggestion of which I am aware, that indicates the importance of the upper atmosphere in the transmission of electrical waves over the earth's surface is contained in a paper which the late G. F. Fitzgerald read at the British Association Meeting in 1893. In discussing the probable period of an electrical oscillation of the earth as a whole, he remarks that—

> The period of oscillation of a simple sphere of the size of the earth, supposed charged with opposite charges of electricity at its ends, would be almost one-seventeenth of a second; but the hypothesis that the earth is a conducting body surrounded by a nonconductor is not in accordance with the fact. Probably the upper regions of our atmosphere are fairly good conductors.

He then proceeds to calculate the period of oscillation considering the earth and upper atmosphere as two concentric spherical conductors and finds that if the height of the region of the aurora, i. e., of the conducting layer, be 60 miles the period comes out at 0.1 second, while, if the height be 6 miles, the period becomes 0.3 second.

[1] *Reprinted by request from* Year Book of Wireless Telegraphy and Telephony, 1914. Marconi Press Agency (Ltd.), London, [1914]. p. 504-512.

[2] Erskine-Murray, J. Handbook of wireless telegraphy. London, 1907.

At the time this was written wireless telegraphy, in the modern sense, had hardly been thought of, and no application of Fitzgerald's idea was made to radiotelegraphy until 1902, when A. E. Kennelly[3], in the Electrical World, suggested that an upper reflecting layer might be the cause of the abnormally long ranges occasionally obtained by night. Oliver Heaviside also, in his article "Theory of electrical telegraphy" (Encyclopaedia Britannica, 10th edition), says:

> There may possibly be a sufficiently conducting layer in the upper air. If so, then waves will, so to speak, catch on to it more or less. Then the guidance will be by the sea on one side and the upper layer on the other.

It is clear, therefore, that in the opinion of Fitzgerald the upper conducting air actually existed, and that Kennelly and Heaviside looked upon its existence as probable.

The diagram (fig. 1), which forms an illustration to the chapter on transmission in the first and succeeding editions of the writer's Handbook of Wireless Telegraphy[2], published at the commencement of 1907, was arrived at from similar considerations in combination with the known facts of the conductivity of gases at low pressures, of the height of the auroral discharge and of the constant presence of ionization in the upper atmosphere. It was

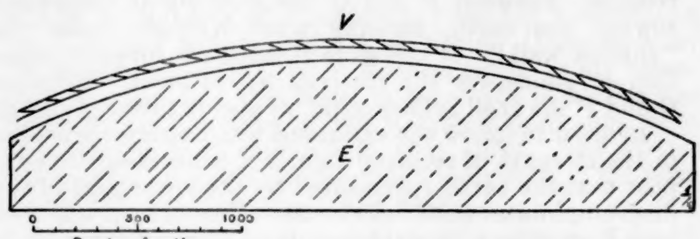


FIG. 1.—A portion of the earth and atmosphere drawn to scale. *E*, the earth; *V*, outer space. Shaded portions indicate conductors, the unshaded strip between them is the dielectric of wireless telegraphy. (*From* Erskine-Murray, Handbook of Wireless Telegraphy, 1907.)

thus an immediate deduction from the knowledge available at the time.

As regards the ionization of the upper atmosphere, I may say that as early as 1892 I wrote a paper in which a calculation was made of the currents in the upper atmosphere which would be necessary to account for certain magnetic storms and suggested that these currents might be due to streams of electrified particles entering the atmosphere from the outside. A great deal of work on similar lines has been done lately by Birkeland. That ordinary sunshine containing ultra-violet light ionizes air was well known, as also the fact that ionization does not die out at once.

The diagram (fig. 1) indicates that if the under surface of the upper conducting layer were sufficiently sharply defined, the waves would be reflected downwards and might, therefore, increase the strength of signals received, the wave form becoming ultimately—i. e., at great distances—cylindrical instead of hemispherical, and therefore giving a much slower reduction in the strength of received signals than would occur if the waves were free to extend into upper space or were absorbed by and dissipated in the upper layers. I consider that the existence of this upper conductive layer is no longer a matter of doubt, and that the problems now in the process of solution involve only its form and functions. To be able to discuss these we must leave for the meantime the physical side of the question and look into the evidence obtained in the actual working of wireless telegraph stations.

[3] *See also* A. H. Taylor in this REVIEW, April 1914, 42: 211, fig.—Editor.

The first time that an obviously atmospheric effect was noticed was in 1902, when Mr. Marconi received signals from Poldhu on board the steamship *Philadelphia* at nearly twice as great a distance by night as by day.

Since the conductivity of the surface of the sea is not appreciably different by day and by night, it is evident that the cause of this increase of distance of transmission at night must be some atmospheric variation. Mr. Marconi suggested that at the time the effect might be a local one, i. e., a loss of energy at the transmitting aerial due to ionization by daylight of the air in its immediate neighborhood. This theory, however, does not fit in with the more recent observations of the phenomena, which clearly indicate that the cause is situated in the atmosphere intervening between the stations and is not due to variations in the amount of energy radiated.

Take, for instance, Edward's observations on transmission by day and by night on the coast of British Columbia, and in particular the case of communications between Victoria, Pachena Point, and Ikeda Head. These three stations lie in nearly a straight line, Pachena Point being about 75 miles and Ikeda Head about 400 miles northwest of Victoria. Electric waves in transmission from Victoria to Ikeda Head thus pass Pachena, and if they traveled by the shortest route, i. e., along the earth's surface, should be received there.

As a matter of fact, however, with the small power station originally installed, it was very difficult to communicate between Victoria and Pachena at all, either by day or night, whereas communication was easily maintained between Victoria and Ikeda Head almost every night, though not by day.

There appears to be only one rational conclusion which can be drawn from these observations, viz, that at night the waves which reached Ikeda Head actually passed Pachena high overhead without approaching the ground on which the station stands; that is to say, they rise from Victoria and are bent down again after they have passed over Pachena Point. There is no other way by which they could get to Ikeda Head without affecting the intermediate station. We have thus a direct proof from actual wireless operations that there must be some stratum of the upper atmosphere which, at least by night, is not transparent to electric waves but reflects or refracts them downward from its lower surface.

From the consideration of the physics of the atmosphere and from actual wireless observations, we have thus obtained two quite independent proofs of the existence of the upper conducting layer depicted in figure 1.

The above are, of course, only instances taken from a very large number of observations, all of which go to prove the existence of a strengthening of signals due to reflection from the upper atmosphere. These "freak" transmissions occur in all latitudes, but mainly in the fine-weather belts which surround the world between latitudes 20° and 45° on both sides of the Equator. It is also there that the atmosphere is, as we know from the work of meteorologists, in a comparatively steady condition such as must favor the formation of a smooth reflecting layer. There is also evidence which shows that stormy weather is unfavorable to transmission.

It is notable that many of the greatest distances of "freak" transmission have been in large part over land, and indeed over high mountains—further proof that in these cases the main conductor is not the earth but the upper shell.

It is also a fact that signals between stations at a comparatively small distance from one another are not appreciably strengthened at night, and this further confirms

the idea that the increase at greater distances is due to reflection. In the case, for instance, of Victoria and Pachena Point the angle at which the waves would have to be reflected from the upper layer is about 45° or more in order to reach the latter station. So high an angle is, of course, very unfavorable to reflection and a very small proportion, if any, of the waves received at Pachena Point could come that way. For Ikeda Head the angle would only be about 10°, which is very much more favorable; hence, as the phenomenon of better night transmission is observed at the latter, reflection is indicated. (See fig. 2.)

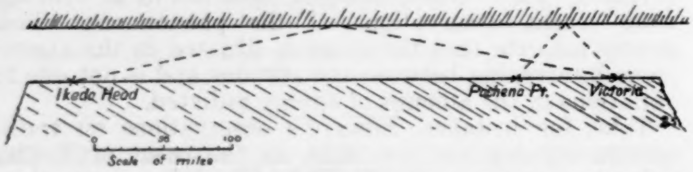


FIG. 2.—A portion of the earth and atmosphere between Victoria and Ikeda Head. *A*, Victoria; *B*, Pachena Point; *C*, Ikeda Head.

We may take it, therefore, that it is practically certain that during the night the waves are conducted to great distances by two conducting surfaces, the earth and the shell outside it. The argument put forward by Dr. Eccles against conductive transmission, viz, that a high receiving aerial is better than a low one, is really fallacious and neglects Poynting's proof that in all electrical transmission the energy travels via the dielectric and not in the conductor. Of course, a higher aerial will show greater energy in the receiving instruments in any case, for the integral effect of the electromagnetic forces on it will be greater than that in a small one, whether the waves be conducted or free. I have demonstrated this many times in lecturing on the subject by using a long horizontal straight wire to represent the conducting strip of ground between the transmitting and receiving stations, with two vertical wires attached to it as aerials.

It seems, therefore, that at night the lower surface of the conducting shell is often well defined, thus becoming a good reflector, while during the day the transition from the upper and conducting to the lower and nonconducting air is gradual—the surface, in fact, becomes fuzzy and incapable of giving a clear reflection.

We now come to the curious phenomena which take place at sunrise and sunset. Let us see what function the atmosphere performs in these, after stating generally the results which have been deduced from Mr. Marconi's interesting observations at Clifden and Glace Bay and from those of later workers.

In a paper on the "Daylight Effect in Radiotelegraphy," read to the Institute of Radio Engineers in July, 1913, Prof. A. E. Kennelly sums up the experimental facts and shows, as he says in his summary, that "changes of intensity of signals near sunrise and sunset are explained by reflecting effects which may be expected at the boundary surface or 'shadow wall' between darkness (air of small conductivity) and illumination (ionized air of marked conductivity)."

This is good if it applies only to the middle atmosphere below the layer, which, as we have seen, must be a good conductor even at night and above the lower layers, which under no conditions ever become appreciably conductive; but it neglects the fact that there are also long night ranges to be explained which demand something essentially better than merely a nonconducting atmosphere.

The real effect is, therefore, something like that shown in figure 3, a figure which I have frequently drawn on the blackboard for the benefit of a class during the past six years.

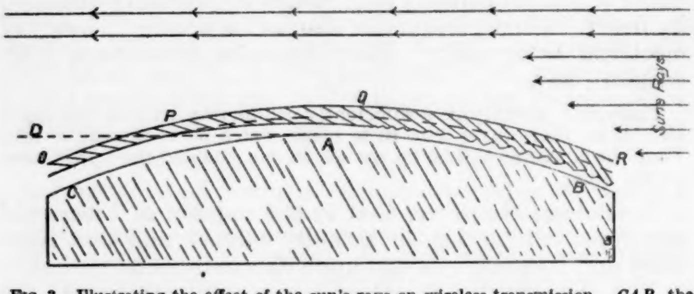


FIG. 3.—Illustrating the effect of the sun's rays on wireless transmission. *CAB*, the earth; *OPQR*, the conducting shell; *AD*, line dividing sunshine above from darkness below; *A*, station where the sun is just rising.

I have indicated that over the station *A*, at which sunrise is just taking place, the conducting shell is at least as sharply defined as during the night, and is therefore capable of reflecting; while at *B*, where the sun is high, the under surface of the shell is indefinite and no longer reflects. Between *P* and *Q* the shell slants downward toward the earth, forming what Kennelly calls the "shadow wall." It therefore strengthens forward radiation or condenses the received waves at *A*. Between *O* and *P* the shell is horizontal, as also between *Q* and *R*.

In order to follow the variations which sunrise produces in the strength of received signals it is necessary to suppose that the earth, represented by the lower part of the diagram, rotates slowly clockwise. The stations will then pass from where, in darkness, the height of the shell is great to where, in full daylight, it becomes lower and less well defined; and in their passage their positions relative to the shell will indicate the variations in signals.

To study the sunset effect we may turn the earth counterclockwise, starting with both stations in full daylight, i. e. on the right, and turning them gradually over into darkness. The point of view will in this case be from above the North Pole, while in the use of the diagram to illustrate sunrise it was from above the South Pole.

As Dr. Kennelly points out, the boundary between light and darkness is a line which is only due north and south at the times of the equinoxes. At other times of the year it has a northerly and easterly, or northerly and westerly slant, according to the season of the year. This boundary line is in fact a great circle of the globe, the axis of which is always directed toward the sun and therefore cuts the surface of the globe at some point on the ecliptic. Sunrise and sunset effects, therefore, vary from month to month, and depend not only on the times of sunrise and sunset, but also on the angle between the fixed great circle along which transmission takes place from the one station to the other and the great circle separating day from night.

In conclusion, I would suggest that there is another factor in the case of which no account has hitherto been taken. This is the possibility that there may be resonance to some of the natural wave lengths of the oscillator, consisting of the earth and the shell. These wave lengths are many in number and include a range of waves of lengths h, $2h/3$, $2h/4$, etc., where h is the distance between the earth and the shell. Thus, if the height of the shell be 50 kilometers, these natural wave lengths would be 50

kilometers, 33.3 kilometers, 25 kilometers, and so on; while if the height were different the whole series would be different. We have here, therefore, another possible explanation of the fact that both with damped and undamped waves it has been observed that at certain times certain wave lengths are more easily transmitted than others. I would suggest that, although this may be due to interference of direct and reflected waves, it may also be due in part at least to a change in the height of the shell, whereby the natural resonance wave lengths of the terrestrial oscillator are altered.

RAINFALL AFTER BATTLE.[1]

By Gen. H. M. Chittenden, U. S. Army.

[Dated Port of Seattle, Seattle, Wash., October, 1914.]

To the Editor: I noted in the Post-Intelligencer [of Seattle, Wash.] an extract from Pearson's Weekly (London) in regard to the effect of battles in producing rain. There seems to be an almost universal belief in a direct relation between these two phenomena. Several years ago, in preparing a paper on the influence of forests on streamflow, I had a great deal of correspondence with Col. T. P. Roberts, of Pittsburgh, a brother, I believe, of Prof. Milnor Roberts, of our university [University of Washington, Seattle]. Col. Roberts called to my attention the fact that this belief in the effect of battles was prevalent in the days of the Roman Empire, and cited a paragraph from Plutarch to that effect. The matter seemed so interesting to me that I inserted it in the form of the following footnote in my paper:

> Though admittedly irrelevant, the interesting character of the following item justifies its insertion here, as another example of the old saying that "there is nothing new under the sun." Everyone is familiar with the superstition (possibly it deserves a better name) that great battles produce rain. The vibrating effect upon the atmosphere of the multitudinous detonations of artillery is generally ascribed as the cause. Read this from Plutarch, who flourished 45–125 A. D.: "It is an observation also that extraordinary rains pretty generally fall after great battles; whether it be that some divine power thus washes and cleanses the polluted earth with showers from above, or that moisture and heavy evaporation, steaming forth from the blood and corruption, thickens the air, which naturally is subject to alterations from the smallest causes."

The fact that this belief is thousands of years old and antedates by at least a thousand years those physical causes (artillery bombardments) which are now the explanation assigned to this assumed relation, demonstrates how uncertain the relation itself is. The recent occurrences in France furnish no proof of the theory. There have been considerable spells of both fair and rainy weather, though conditions as to artillery practice were practically the same. On the basis of actual demonstration, therefore, it must be admitted that the theory does not have much to stand on.

Even if it were an established fact that heavy detonations or bombardments tend to condense the moisture of the atmosphere and cause precipitation, its value in a practical way would still be very questionable. When the atmosphere is well charged with moisture, natural causes lead to its condensation to an extent which probably satisfies the average need for it. Artificial rainmaking is not required at such times, but only in seasons of drought, when Nature's efforts in that direction seem to be suspended. But the power to produce rain at such times, even admitting its efficacy at others, fails because there is nothing to make rain of. No matter how efficient the pump, one can not pump water when the well is dry. So we are thrown back upon the greater problem of getting an atmosphere laden with moisture, and over this matter man has no more control than he has in restraining a surcharged atmosphere from spilling its moisture too rapidly and causing great floods.

[1] Published in the Seattle Post-Intelligencer of Oct. 5, 1914, and later revised by the author for the Monthly Weather Review.

THE HOURLY FREQUENCY OF PRECIPITATION AT NEW ORLEANS, LA.

By Edward D. Coberly, Local Forecaster.

[Dated Weather Bureau, New Orleans, La., Sept. 1, 1914.]

While the precipitation at New Orleans during the greater portion of the year perhaps does not differ materially, either in amount or in frequency of occurrence, from that at other stations along the Gulf coast from Florida to Texas, the rainfall during the months of June to September, inclusive, does possess certain characteristics which distinguish it very distinctly from that of other localities in the area mentioned. With a view to bringing out these peculiar characteristics of the summer precipitation at New Orleans, a study of the hourly amounts of precipitation and also the frequency of the precipitation during the different hours was undertaken, covering the period for which the hourly records are available at New Orleans, namely, 1905 to 1913, inclusive. The data collected in this connection have been summarized in a table which shows the number of times during each hour, for the entire period covered, that precipitation of 0.01 inch or more occurred, and in four charts showing graphically the diurnal march of the frequency of the precipitation for each month of the year.

As a glance at the chart (fig. 1) will show, from October to May, inclusive, the precipitation is very evenly distributed throughout the 24 hours, there being no marked excess in the number of showers at any particular period of the day. In June, however, and extending through September, the tropical characteristics of the rainfall become very marked, and 60 per cent of all the hours with rainfall occur from 10 a. m. to 6 p. m. and 40 per cent between the hours of 12 noon and 4 p. m. The greater portion of this summer rainfall occurs as the accompaniment of local thundershowers, which are recorded on an average of nearly half the days during the four months June to September, being most frequent in July and least frequent in September. The distribution of barometric pressure most favorable to these daytime thundershowers is an area of high pressure centered on the south Atlantic coast and gradually diminishing in intensity westward toward Texas. The frequent occurrence of these convectional rains in southeastern Louisiana, and especially in New Orleans and its immediate vicinity, is no doubt materially increased by the topographical surroundings of the city. It is almost entirely surrounded by water, thus giving to its summer climate a great many of the characteristics of a semitropical island, that is, clear weather during the night and early morning hours, rapidly increasing cumulus clouds during the forenoon, culminating in showers during the warmest hours of the day, together with an absence of great extremes of temperature.

The hour of greatest precipitation appears to become progressively later in the afternoon as the season advances, the period of most frequent rainfall in June being 1 p. m. to 4 p. m., there being not much variation in any of the afternoon hours; in July it is 1 p. m.; in August, 2 p. m.; and in September, 3 p. m.

That the summer rainfall at New Orleans is markedly influenced by its topography is shown by a comparison of the number of days on which 0.01 inch or more of precipitation occurs at New Orleans, with the same records at other stations located along the Gulf coast, but not so nearly surrounded by water. For the purpose of this comparison, the records of New Orleans and Lake Charles, La., Pensacola, Fla., and Galveston, Tex., have been chosen, and it is found that the average number of rainy days for the four months considered is as follows: New Orleans, 53; Lake Charles, 34; Galveston, 36; and Pensacola, 47.

A study of the intensity of the hourly rainfall was also made, but the short period covered by the records and

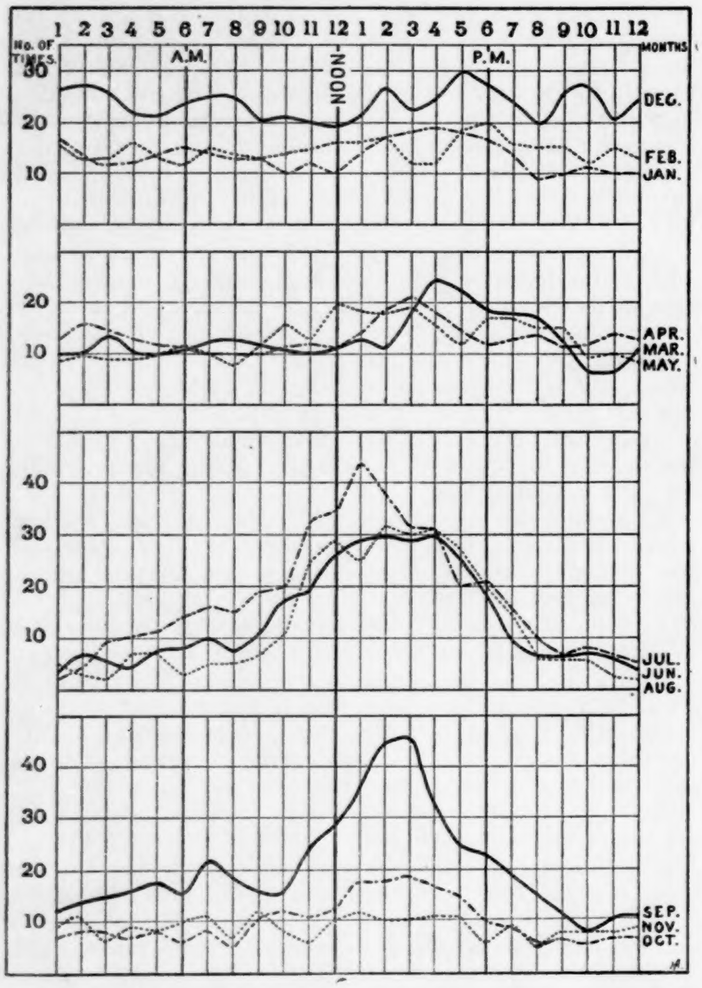


FIG. 1.—Curves of hourly frequency of precipitation at New Orleans, La., for each month (1905-1913).

the possibility of the occurrence of excessive rainfall during any hour render it impossible to draw any conclusions as to the hour of most intense precipitation.

It is believed that a study of the hourly precipitation records, especially a study of the frequency, will open up a new field for the use of Weather Bureau records, because contractors, engineers, agriculturists, and others whose occupations necessitate their working out of doors would, by means of these hourly frequency data, be enabled to arrange their work and that of their employees, so that it would be performed during those hours when there is the least likelihood of its being interrupted by rainfall, and in this way, perhaps, a great deal of valuable time would be saved, not to speak of the saving of damage suits, etc., on account of baggage, produce, and other articles being injured by dampness when being transferred at a time of the day when there is more probability of rainy than of dry weather.

The table and charts are appended in order that those who may care to do so can have the exact information at hand and can draw their own conclusions.

TABLE 1.—*The number of times 0.01 inch or more of rain was recorded at New Orleans, La., during 9 years, for each hour of the 12 months.*

Months.	A. M.—Hours ending at—											
	1	2	3	4	5	6	7	8	9	10	11	Noon.
January	17	13	12	12	14	15	14	13	13	10	12	10
February	16	13	13	16	13	12	15	14	13	14	15	16
March	10	10	14	10	10	11	13	12	11	11	10	11
April	13	16	15	13	12	11	10	10	10	11	12	11
May	9	10	9	9	10	11	10	8	12	16	13	20
June	3	7	5	4	8	8	10	7	11	18	19	27
July	2	4	9	10	11	14	16	15	19	20	33	34
August	5	3	2	7	7	3	5	5	7	11	25	29
September	12	14	15	16	18	15	22	18	16	15	25	28
October	7	8	8	7	8	6	9	5	11	12	11	12
November	9	11	6	9	8	10	11	7	12	8	6	10
December	26	27	26	21	21	24	25	25	20	21	20	19

Months	P. M.—Hours ending at—											
	1	2	3	4	5	6	7	8	9	10	11	Mid't.
January	14	17	18	19	18	17	14	9	10	11	10	10
February	16	17	12	12	19	20	16	15	15	12	15	13
March	13	11	19	25	22	18	18	17	12	6	6	11
April	14	19	21	18	14	12	13	14	11	12	14	13
May	19	18	19	16	12	17	17	15	15	9	10	8
June	29	30	29	30	25	18	9	6	6	7	6	4
July	44	38	31	31	20	21	16	10	7	8	6	5
August	25	32	30	31	27	20	15	6	6	6	3	2
September	37	45	46	32	24	23	19	15	12	8	11	11
October	18	18	19	17	15	10	9	6	7	6	7	7
November	12	10	10	11	11	6	9	6	8	8	8	9
December	21	27	22	24	30	27	24	19	26	27	20	24

DROUGHT VERSUS IRRIGATION.

Many years ago the MONTHLY WEATHER REVIEW called the attention of our numerous observers and correspondents to the importance and possibility of providing beforehand for the supply of water that would be needed in the long droughts to which this country is subject. Of recent years everyone has heard of the droughts and the disastrous loss of crops in that western region that in 1850 was known as the "great American desert." The great progress that has been made since those days has enabled western agriculturists to diminish the danger of a disaster from droughts; indeed, by the help of the Reclamation Service they are turning deserts into gardens. But meanwhile we must repeat our advice of years ago, which seems especially applicable to New England and the Middle States, to the effect that it is not necessary for a farmer to be at the mercy of droughts and uncertain local rains. A drought of 30 days during June or July or August may be as injurious in the Atlantic States as anywhere else, and yet experience shows that an abundance of water is available at a short distance below the ground. A recent Farmers' Bulletin, No. 592, of the Department of Agriculture, although it appears to be specifically intended for western grazing lands, contains abundance of good suggestions applicable to the Atlantic States. Deep bored wells and springs often furnish sufficient water for local crops and cattle if only it is used economically. The expense of a well and pump is saved in one or two years by the resulting increase of

the local crop, and the combination of several farmers in maintaining and using a single deep well should generally be practicable. Doubtless a special edition of Farmers' Bulletin No. 592 for the use of farmers in the Atlantic States is desirable, but meanwhile that bulletin itself should not be neglected.

UNIT OF ACCELERATION.

In the recent MONTHLY WEATHER REVIEWS, pages 5, 100, 141, 143, we find various suggested terms for the unit of acceleration, some one of which would be convenient in daily meteorological use. In Nature (London), August 13, 1914, page 611, Dr. Otto Klotz, director of the Dominion Observatory, Ottawa, writes:

"So long ago as 1909 Weichert used the term 'gal' for that unit in the report of the Göttingen earthquake station, being the first syllable of Galileo, whence Mr. Whipple derives his 'leo.' Others, as well as myself, have used 'gal,' or rather 'milligal,' in analyses of earthquakes. A 'milligal' is approximately a millionth of *g*. *Dyne* is the unit of force; *gal* the unit of acceleration."

SECTION III.—FORECASTS.

STORMS AND WARNINGS FOR SEPTEMBER.

By EDWARD H. BOWIE, District Forecaster.

[Dated, Washington, Oct. 10, 1914.]

At the beginning of the month pressure was high over the western Atlantic Ocean as indicated by reports from the Bermudas and over Montana, while low pressure prevailed over the Grand Banks and from the southern Plains States to the upper Lake region, the main center, however, being over Lake Michigan. Showers were in progress in the upper Mississippi Valley and the upper Lake region. The low center indicated above moved northeastward during the two days following and was immediately followed by another low pressure area from the Canadian Northwest, which passed along the northern border to the upper St. Lawrence Valley by the 4th. Precipitation occurred generally from the Plains States eastward over the Northern States. In connection with the disturbance last mentioned, fresh winds occurred over Lakes Huron and Erie, for which small craft warnings had been previously issued.

The Montana high area moved eastward and was central off the South Atlantic coast by the morning of the 7th.

Pressure became low over the Northwest on the 3d, and a low moved eastward along the northern border. A secondary development which appeared in the trough of this storm was on the morning of the 6th over northern Lake Michigan, and small craft warnings were ordered. During the next two days this disturbance passed to the Canadian Maritime Provinces. Showers and thunderstorms attended its passage in the upper Mississippi Valley, Ohio Valley, the Lake region, and New England.

A recovery from this depression set in over the Canadian Northwest, and a high center was over Manitoba on the evening of the 6th, moving thence eastward to the St. Lawrence Valley by the 11th. It was reenforced on the following day by a high pressure area that first made its appearance on the North Pacific coast on the 8th. This high persisted over the lower St. Lawrence Valley and northern New York State until the 17th, when another high area appeared over western Ontario. On the morning of the 18th there was one center over eastern Ontario, whence it settled southward to the South Atlantic coast by the 22d.

During the 6th pressure decreased over British Columbia and the northern plateau region, and by the following morning a trough of low pressure extended from British Columbia to Colorado. It advanced slowly eastward during the next 48 hours, and on the morning of the 9th the trough extended from Saskatchewan southward through eastern Colorado. The northern part of the disturbance remained nearly stationary for several days, while a secondary of weak proportions developed over eastern Colorado and moved eastward to West Virginia by the evening of the 11th, causing showers over the middle tier of States between the Rocky and Appalachian Ranges. Several other secondaries developed over the Plateau and southern Rocky Mountain regions, but owing to the abnormal development and extent of the high pressure area in the East were unable to find a passage eastward; showers and thunderstorms occurred, however, with great persistency over the Plains States. Pressure continued low over the Northwest until the 16th.

On the morning of the 15th reports received from the vicinity of the Bahamas indicated the inception of a disturbance over that region. Pressure falls of 0.18 inch and 0.10 inch were reported from Nassau and Turks Island, respectively, and the following message was disseminated to shipping:

> Strong indications of a disturbance in vicinity of Bahama Islands; direction of movement unknown. Strong northeast winds, probably increasing off South Atlantic coast.

On the evening of the 15th the following notice was issued and northwest storms warnings ordered displayed on the eastern coast of Florida and northeast warnings from Jacksonville to Hatteras.

> Disturbance off east Florida coast and apparently moving north or northwestward. Strong northerly winds off South Atlantic coast. Advise ships to exercise caution.

The storm on the morning of the 16th was off the eastern coast of Florida and on the evening of that date off the southern Georgia coast. Instead of passing northward up the coast, as is customary with disturbances of this character, it advanced westward over southern Georgia and continued its progress westward to the Texas coast, where it disintegrated. This disturbance caused winds of gale force along the south Atlantic coast, and vessel reports indicate that it was even more severe off the Georgia coast. After reaching the land the storm decreased in intensity and caused general rains in the South Atlantic and Gulf States.

A low center was central on the North Pacific coast on the 18th, which during the next two days advanced slowly eastward in the form of a trough, extending on the morning of the 20th from Manitoba to Arizona. It continued to move slowly eastward, being central over the Mississippi Valley on the 22d and over Atlantic coast districts on the 25th. In the extreme southern end of this trough a secondary developed, which, passing east-northeastward from the southeastern Texas coast, was central on the 24th off the Alabama coast. On the previous afternoon storm warnings were issued on the Gulf coast from Pensacola to Galveston. On the evening of the 24th warnings were ordered from Jacksonville to Hatteras. The storm passed to the South Atlantic coast by the morning of the 25th, and thence north-northeastward to a position off Nantucket by the following morning. On the 26th it was near Newfoundland with greatly increased intensity, a reading of 29.28 inches being reported at St. Johns. Precipitation occurred quite generally throughout the country, except in the Southwest.

An extension from the subpermanent high-pressure area of the North Pacific Ocean appeared over Idaho on the morning of the 21st. It moved thence slowly eastward to the southern Plains States during the following 24 hours. During the 24th it was reenforced by another high pressure area from the Canadian Northwest, which was central on

the evening of the 24th over Minnesota. It passed thence southeastward to West Virginia by the 27th, when another high area was central over eastern Lake Superior. This latter became the main high and passed thence southeastward to the south Atlantic States by the evening of the 29th. Frosts occurred quite generally in connection with these two highs over the upper Mississippi Valley, the Lake region, the northern portion of the Ohio Valley, and the Middle Atlantic, and New England States, warnings being successfully issued in the majority of cases. On the morning of the 29th low temperature records for the month of September were broken at three stations in Atlantic Coast States. Another offshoot from the Pacific high area was central on the north Pacific coast on the evening of the 27th, and moved thence eastward to the northern upper Lake region by the end of the month.

A low-pressure area that was over western Alberta on the 26th moved eastward along the northern border and was central at the last of the month off the New England coast. Very little precipitation attended its passage.

NORTHERN HEMISPHERE PRESSURE.

Alaska.—Pressure averaged decidedly above normal over the Aleutian Islands and slightly above normal over Bering Sea, as indicated by reports from Nome. Over southeastern Alaska pressure averaged below normal, while elsewhere pressure was about the seasonal average. Lows occurred about the 4th, 9th, 12th–13th, 21st, 25th–26th, and 28th; and highs about the 1st, 6th, 11th, 14th, 17th–18th, 24th, and 29th–30th. The most pronounced high of the month occurred about the 15th.

Honolulu.—Pressure averaged below normal, being almost continuously below from the 1st to the 26th and above from that time until the end of the month.

Horta.—Pressure averaged slightly above the normal. Lows occurred on the 2d–3d, 5th–6th, 17th, 23d–24th, and 27th–28th; and highs on the 1st, 8th–14th, and 19th–22d, the most important being the one that crested on the 12th.

FORECAST DISTRIBUTION.

By GEORGE W. SMITH.

[Dated, Forecast Division, Weather Bureau, Sept. 1, 1914.]

The daily distribution of weather forecasts by the Weather Bureau, Department of Agriculture, has attained such success, the forecasts and warnings are so popular and affect all affairs to such an extent, that a paper contrasting the small beginnings of this service with its present condition must prove interesting to a large number of readers. Mention of "cautionary" or storm signals and also of the Daily Weather Map will be made, but only in a casual way, as these should receive the separate consideration that their importance merits.

Storm studies had been begun by James P. Espy, who was appointed "Government meteorologist" in 1840. Espy died in 1860, but his work was continued by the Smithsonian Institution and later by the Cincinnati Observatory until 1870. The official collection of meteorological reports by telegraph was begun by the Signal Corps of the United States Army, under the Chief Signal Officer, Gen. Albert J. Myer, by authority of Congress, see "Public Resolution No. 9," approved February 9, 1870.

The first reports and bulletins of the Signal Office were for November 1, 1870, 7:35 a. m., 4:35 p. m., and 11:35 p. m., Washington time, at 24 selected stations of observation. The reports received from these stations were prepared in the form of tabulated bulletins, and these were given to the "press" three times a day at 10 a. m., 7 p. m., and 1 a. m., respectively. These reports were promptly plotted at Chicago, Ill., by Prof. I. A. Lapham, of Milwaukee, Wis., on charts for the purpose of studying the probable occurrence of storms on the Great Lakes. The first notice of an expected storm was sent by Prof. Lapham to Gen. Myer, and telegraphed by the latter officially from the central office at Washington, D. C., on November 8, 1870. It was telegraphed to several stations along the Lakes and bulletined for the benefit of shipping interests there.

These bulletins of the weather conditions early attracted considerable attention, and those particularly interested made a strong demand that "deductions" from the collected reports be made and published.

On January 3, 1871, the services of Prof. Cleveland Abbe, then of the Cincinnati Observatory, were secured, and since that date he has been continuously identified with the weather service of the United States. The compilation of maps, "synopses," and "probabilities" was begun by him at once. The former showed the weather conditions at the hours of observation, and the latter showed deductions made from the telegraphic reports as to probable weather conditions for the ensuing eight hours.

The first published forecasts of the weather were issued on February 19, 1871; these received commendation at first, but afterwards severe criticism because the public expected unreasonable verification of the predictions. As the public became better acquainted with published "probabilities" it demanded that reporting stations be established in the interior of the country at points not previously represented and that predictions be made for the interior sections of the country, and for the benefit of river navigation and the agricultural interests. Accordingly, under an act of Congress approved June 20, 1872, the Secretary of War was directed to provide such stations, signals, and reports as might be found necessary for the benefit of agricultural and commercial interests throughout the United States. This considerably extended the scope of the work of the service.

Up to May 1, 1871, the maps and bulletins were prepared by manifold process, but on that date successful lithographic printing of the maps was begun. This lithographed weather map was favorably received and even became popular; before long it led to the publication, under the direction of the central office at Washington, D. C., of similar charts at New York, N. Y., Philadelphia, Pa., Cincinnati, Ohio, Chicago, Ill., and New Orleans, La. The press bulletins were also prepared three times a day, and contained, first, the "synopses"; second, the "probabilities"; third, the "special storm warnings" when ordered. The number of weather maps and tabular bulletins issued at Washington, D. C., in 1871 averaged 35 of the former and 60 of the latter, daily.

The "synopses" and "probabilities" were given to the public as promptly as possible. The contents of the bulletin were telegraphed to the several stations and there posted. Arrangements were made for the display of "cautionary" or storm signals at 24 stations. These stations have been gradually multiplied until they number 369 at present [1914]. A signal flag was early adopted to indicate "cautionary" or storm warnings. It was a square red flag with a square black center (see fig. 13),

and was first officially displayed at Oswego, N. Y., on October 26, 1871. About that same time it was also displayed on the North Carolina coast.

The increased demand for the predictions caused the Secretary of War to request the cooperation of the Post Office Department in the dissemination of the weather bulletins. The scheme was approved June 8, 1872. The Postmaster General offered hearty cooperation with the Signal Corps of the Army, and on December 9, 1872, instructed postmasters to lend their aid by specially speedy forwarding of the mailed bulletins, and by posting the reports in conspicuous places in their offices. The Post Office bulletin began June 15, 1873. A publication was thereafter issued under the title "Post Office Bulletin," and this bulletin was prepared at 15 central or distributing stations, to which stations the synopses and probabilities were telegraphed from Washington, D. C. In this way two copies of the bulletin were sent to every post office within the zones of these stations that could be reached before 4 p. m. of the afternoon of the day that the bulletin was issued, reaching 4,391 post offices. The total issue for the year ending November 1, 1873, was 895,014, and of the weather map 320,770, a grand total of 1,215,784 during the year. The printing of the Post Office Bulletin was begun at Washington on January 14, 1873. Previously the publication had been manifolded. The "press" was always ready to print weather bulletins and reports as news, and thus the information secured a wider distribution than appears in the above figures.

As usual in new ventures, many difficulties were met, but the hearts of those engaged were in the work, and as obstacles presented they were overcome as far as the funds available would allow.

With experience, the accuracy of the "probabilities," so called, improved from 69 per cent verified the first year to 84 per cent verified in 1874.

So great was the demand for these weather reports that in January, 1874, arrangements were perfected for the printing of the bulletins at several stations outside of Washington. In this year also the title of the "Post Office Bulletin" was changed to "Farmers' Bulletin," and its edition and distribution increased. The bulletin at this time was received at 6,364 post offices throughout the country. There were 20 central or distributing stations from which they were sent out. The midnight reports continued to be the basis of the deductions of predictions that were printed and distributed.

It was through the hearty cooperation of the Post Office Department that so many of the post offices in cities, towns, villages, and hamlets were reached and the information was made available to those engaged in agricultural pursuits. Most of the post offices received the 9 a m. bulletins as early as 2 p. m. of the same day.

In 1875 some railroad companies saw the usefulness of "probabilities" in connection with the operation of their roads, and began sending the information to their stations by railroad telegraph.

The term "probabilities," early given to the forecasts, was changed to "indications" in 1876. The need of indications and weather reports for locations on the Pacific coast was manifested, and a station for the printing and distribution of indications was proposed for Sacramento, Cal.

The division of the country into districts, as then used, was as follows: New England, Middle States, South Atlantic States, eastern Gulf States, western Gulf States, lower Lakes, upper Lakes, Tennessee and Ohio Valleys, upper Mississippi Valley, and lower Missouri Valley.

The preparation of indications for the Pacific Coast States began in February, 1879 (although a successful prediction of a storm was made in April, 1871), and that region was divided into three districts, viz, northern Pacific, central Pacific, and southern Pacific.

In 1879 an arrangement was made whereby the railroad companies were provided with the "synopses" and "indications" in the form of a "railroad bulletin" to be posted in their local stations. There were 36 railroads cooperating in this way, and the bulletin posted at 1,212 stations. The number of railroad companies thus cooperating with the Signal Service was increased to 95 in 1880, and the number of stations served in this way was 2,889.

The need was felt for further subdivision of the western country into regions or districts in connection with weather "indications," and accordingly in 1881 the following subdivisions were adopted for the purposes of the weather service: Extreme Northwest, Northern Slope, Middle Slope, Southern Slope, Northern Plateau, Middle Plateau, and Southern Plateau.

In 1881, for the first time, special bulletins were prepared for the press containing meteorological information of popular interest. They treated especially of high winds, severe storms, heavy rainfall, frost, sudden and extreme changes in temperature, and predictions of fair and rainy weather for two days in advance, made when conditions seemed to warrant, for the benefit of health resorts during the season when they were most frequented.

In November, 1879, special frost indications were ordered prepared and telegraphed to New Orleans for distribution for the benefit of the sugar interests. This information was given out by the press; by bulletins at cotton exchanges, sent over the city by telephone; telegraphed to towns and parishes; and where no other facilities were available it was sent by mail. The first indications proving a success, similar frost warnings for the benefit of the orange interests in Florida and of the fruit interests in other sections were begun in 1881 for the first time. In the fall of 1882 the system of "special frost warnings" was extended to benefit tobacco interests. A "system of warnings for northers" in the southwestern section of the country and Texas was in operation. Fourteen railroad companies whose lines passed through the section assisted in disseminating the information.

The first symbols to designate the probable weather conditions were used by the Cleveland, Akron, & Columbus Railway, which inaugurated a scheme for placing symbols on their baggage cars. The symbols adopted were:

Solid red disk..........	to indicate higher temperature.
Solid red crescent.....	to indicate lower temperature.
Solid red star...........	to indicate stationary temperature.
Solid blue disk........	to indicate general rain or snow.
Solid blue crescent....	to indicate clear or fair weather.
Solid blue star.........	to indicate local rain or snow.

These were of sheet iron about 3 feet in diameter with the symbol painted thereon.

This system of disseminating weather information was operated by sending the indications by telegraph to a "middle" station, where the proper symbols were placed on baggage cars at 5 o'clock a. m.

It was through the efforts of Prof. T. C. Mendenhall, of the Ohio meteorological service, that the symbol scheme was first put into practical use.

Flags [see also above, p. 541] as a means for furnishing information as to the probable weather conditions were also employed in 1884 by the Alabama State Weather

Service cooperating with the United States Signal Service, and the scheme consisted of a set of three flags, white, yellow, and blue, giving nine combinations as follows:

White	indicating fair weather and lower temperature
White over Yellow	indicating fair weather and higher temperature.
White over Blue	indicating fair weather and stationary temperature.
Yellow	indicating local rains and higher temperature.
Yellow over Blue	indicating local rains and stationary temperature.
Yellow over White	indicating local rains and lower temperature.
Blue	indicating general rain and stationary temperature.
Blue over White	indicating general rain and lower temperature.
Blue over Yellow	indicating general rain and higher temperature.

A flag adopted by the United States Signal Service to indicate an expected "cold wave" was white with a square black center (see fig. 5). The use of colored rockets or exploding cartridges for use at night in giving notice of expected weather conditions were successfully used at the Grange experiments at Williams Grove, Pa., during August 26 to 29, 1884. This scheme was not put into active general operation. During 1885 the dissemination of weather forecasts (indications) by means of flags was greatly extended. In Ohio flags similar to the symbols used on baggage cars were put in use. The flags were 6 feet square, and white, with the solid red disk, red crescent, red star, and blue disk, blue crescent, and blue star, respectively.

The United States Signal Service and the Alabama State Weather Service, later in 1884, agreed on the following flags:

White (square)	to indicate fair.
Orange (square)	to indicate local rain.
Blue (square)	to indicate general rain.
Black (triangular)	to indicate temperature.
White with black center	to indicate cold wave.

These five signals were actually employed by the Alabama State service; but the Federal Service still hesitated, and in fact never adopted the orange flag for local rains (see below, 1892).

Special consideration was given the adoption of a system of flags to indicate the weather and on March 1, 1887, the United States Signal Service adopted the following:

White (6 feet square)	indicated clear and fair.
Blue (6 feet square)	indicated rain or snow.
Black (pennant)	indicated temperature.
White with square black center	indicated cold wave.

The flag system has since been slightly modified; the latest flags adopted are shown in colors on the accompanying plate.

The distribution of weather information, special warnings, etc., for the benefit of the fruit interests in California was materially extended through the cooperation of the proprietor of the San Francisco Chronicle with the Western Union Telegraph Co., whereby the special warnings were sent throughout the raisin-growing districts during the wet season. The service was further extended by ordering the San Francisco office to telegraph the weather indications to four points or central stations in Oregon, from which the information was further distributed.

The term "indications" which replaced "probabilities" in 1876, was changed to "forecasts" in 1889, since which time the latter term has been in use.

Previous to 1888 the observations on which the predictions of weather were based were taken three times a day—first at 7:30 a. m., 4:30 p. m., and 11:30 p. m.; afterwards at 7 a. m. and 3 and 10 p. m. On July 1, 1888, the hours of observation were changed to 8 a. m. and 8 p. m., seventy-fifth meridian time. During this year the number of places to which the forecasts were being telegraphed was 1,056. The change in the hours of observations necessitated a corresponding change in the distributing centers. As 70 per cent of the places receiving the forecasts could be better served by having the a. m. forecasts, the change from p. m. to a. m. forecasts was made to become effective on and after January 1, 1890.

During the year the use of "whistle signals" was begun. The system was modified somewhat, and the code of whistle signals now in use is as follows: A warning blast of from 15 to 20 seconds' duration is sounded to attract attention. After this warning the longer blasts (of from 4 to 6 seconds' duration) refer to weather, and shorter blasts (of from 1 to 3 seconds' duration) refer to temperature. Those for weather are sounded first:

Blasts:

One long	indicates fair weather.
Two long	indicates rain or snow.
Three long	indicates local rain or snow.
One short	indicates lower temperature.
Two short	indicates higher temperature.
Three short	indicates cold wave.

By repeating each combination a few times, with intervals of 10 seconds, liability to error in reading the signals may be avoided. The whistle signals met with favor for use at outlying places, but they are now used at only a few places.

The weather service branch of the Signal Corps, United States Army, was transferred to the Department of Agriculture on July 1, 1891. During this year "local forecast officials" were appointed, whose duty it was to supplement and amplify the forecasts made and sent out from Washington, D. C. This change was accompanied by a very large increase in the interest manifested by those who would be likely to receive benefit from a foreknowledge of the weather conditions. Closer attention was given to the dissemination of the forecasts and special warnings for the benefit of the agricultural classes and those living in the rural districts. The number of Weather Bureau stations at which the daily weather map was published was increased to 60. Forecasts were now being made for each of the States and Territories, and for from 24 to 48 hours in advance.

The distribution of the forecasts had been now extended so that on June 30, 1891, there were 630 places receiving forecasts for display of weather flags, 90 receiving cold-wave warnings, 51 frost warnings, and 6 in California receiving special warnings of rain. On September 30, 1891, the number of places where weather flags were displayed was further increased to 1,200, about 100 per cent over the number on June 30, 1891. In such cases the Government furnished the information, but the parties displaying the flags provided their own equipment, flagstaff and the flags.

A flag to indicate "local rain or snow" (see above, 1884) was adopted during the year and was put into use on July 1, 1892. It was a blue and white flag, divided horizontally, as shown by figure 3 of the accom-

panying plate. The system of flags now (1914) in use consists of the 8 shown in figures 1 to 17, inclusive.

The furnishing of weather flags by the Weather Bureau was begun by the purchase of 600 sets and supplied to the more important weather display stations. The telephone was used to a greater extent, and the forecasts were thereby made available to a larger number of people in the agricultural districts. The telephone was growing in popularity, and as the lines were extended into the rural districts advantage was taken of it by the Weather Bureau to extend its distribution of the forecasts. In many instances gratuitous distribution was allowed by the telephone companies, who claimed that the weather forecast feature of their telephone service increased its popularity.

On the Pacific coast the distribution of forecasts was further extended, and many expressed their appreciation of the forecast service and of its value to them in connection with their business. Over 100 specially selected places received the forecasts for distribution by telegraph in the Pacific Coast States, in Nevada and Utah.

Interest in the weather forecasts continued to grow, and then, as now, it was found impossible to comply with all the requests for them that were received. The Weather Bureau could authorize the telegraphing of the information only to the most important places where the recipient was so situated as to be able to disseminate it to others.

In the fall of 1894 the bureau put into operation a most valuable means of disseminating the forecasts—logotype forecast card—which soon attracted attention and became a very popular form of giving the information to the public.

The method, as still maintained, is to send the forecasts by telegraph to a central or distributing point, where the recipient sets up the forecasts in specially designed rubber type in a holder, and stamps by hand a number of cards sufficient to serve the town locally, and to supply all such near-by post offices as can receive the postal cards by 4 p. m. of the day on which they are issued.

The Secretary of Agriculture invited the Postmaster General's attention to the forecast card service and requested the cooperation of the Post Office Department. In the United States Postal Guide of June, 1895, was published a letter from the Postmaster General to postmasters inviting them to lend their aid in the prompt handling of the forecast cards.

The following statistics show the extent of the distribution of forecasts at the close of the fiscal year, June, 1895:

AT GOVERNMENT EXPENSE.	
Forecasts	1,920
Special warnings of cold waves	198
Special warnings of frost	419
Emergency warnings	3,494
FREE OF EXPENSE.	
Mail forecast cards	11,732
Telegraph and telephone	1,239
Railroad telegraph	2,348
Railroad train service	1,218

More than 22,000 daily.

Many of those interested in the forecasts expressed their opinions that the saving due to the cold-wave warnings alone was, at a conservative estimate, $12,275,000 during 1895. This represents hardly 10 per cent of the value of all the property saved. The benefits and saving derived from the service largely exceeded its cost.

In 1896 forecast district centers were opened at Chicago, San Francisco, and Portland, Oreg., from which points also the Weather Bureau sent out the weather forecasts. While there was a decrease in the number of places receiving forecasts at Government expense, the number of persons receiving the forecast card was increased more than 10,000.

From the very beginning of the forecast work in 1871 the daily press has contributed very greatly to the success that attended the bureau's efforts to effect a thorough distribution of the forecasts.

During the closing months of the year 1900 the Rural Free Delivery Service was utilized as a means of further extending the forecast distribution to the rural districts. Through the hearty cooperation of the Post Office Department it was possible for the bureau to serve 11,625 families on the rural delivery routes. The Chief of the Weather Bureau was prompt in taking advantage of this branch of the Government service to get the forecasts to those who formerly were unable to obtain them. To further facilitate the distribution of weather forecasts and to increase the usefulness of the Weather Bureau, three new forecast districts were inaugurated at this time: The New England district, with headquarters at Boston, Mass.; the West Gulf district, with headquarters at New Orleans, La.; the Rocky Mountain district, with headquarters at Denver, Colo.; by this new extension of the forecast districts the distribution of forecasts was further facilitated. During this year the number of families receiving forecasts by rural delivery was increased 42,000. The changes in the hours at which the rural carriers left on their routes caused a decrease in the number of families served by that means.

In July, 1902, the "wireless" telegraph was being used for the sending of weather forecasts and storm warnings to vessels at sea.

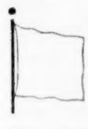
Next to the newspapers the telephone is and has been for a number of years the widest distributer of the weather forecasts. Special attention was given in 1906-7 to extending the distribution of forecasts by free telephone service. One hundred companies in the South Atlantic and Gulf States entered into cooperation with the Weather Bureau, extending the service to 72,500 subscribers. During the spring of 1907 various companies in the States of the Central Valleys began cooperating, and at the close of the fiscal year 1,6[illegible]5 telephone companies were cooperating in the work, representing about 2,000,000 subscribers, an increase during the year of 971,620. The small companies have a distinguishing "call" for the rural subscribers, when the forecast is sent over their wires as soon as received from the distributing center. Nearly all telephone companies had published in their directories a "notice" to the effect that the weather forecast could be obtained from their exchanges free after 11 a. m. daily.

The greatest number of places to receive forecasts at Government expense during any one year was 2,[illegible]70. Special attention was given during the year 1910-11 to warnings for the benefit of growers and shippers of perishable products. This "shippers' forecast card" has become quite popular in the mercantile districts. These cards contain the forecasts of probable temperatures likely to be encountered by perishable goods while in transit. Special attention has also been given to making forecasts of frost for the benefit of the fruit and cranberry interests.

The display of weather forecasts on moving-picture (cinematograph) screens is the latest method employed for giving the information to the public and was successfully begun in March, 1912. This means of forecast display is now used in eight cities.

Weather and Storm Daytime Signals of the U. S. Weather Bureau.

Fig. 1.



Fair weather, stationary temperature.

Fig. 2.

Rain or snow, stationary temperature.

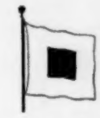
Fig. 3.

Local rain or snow, stationary temperature.

Fig. 4.

Temperature.

Fig. 5.



Cold wave.

Fig. 6.

Fair weather, warmer.

Fig. 7.

Fair weather, colder.

Fig. 8.

Rain or snow, warmer.

Fig. 9.

Rain or snow, colder.

Fig. 10.

Local rain or snow, warmer.

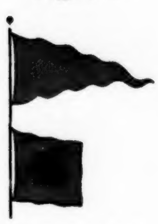
Fig. 11.

Local rain or snow, colder.

Fig. 12.

Small craft warning, moderately strong winds are expected.

Fig. 13.

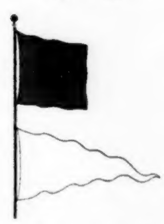


NE. storm winds.

Fig. 14.

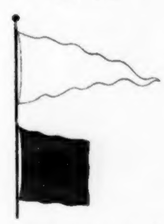
SE. storm winds.

Fig. 15.



SW. storm winds.

Fig. 16.



NW. storm winds.

Fig. 17.

Hurricane, or other severe, dangerous storm.

A red flag with black center indicates that a storm of marked violence is expected; the pennants indicate the direction of the winds. Red pennant, easterly; white, westerly; pennant above, northerly, and below, southerly.

From time to time since the beginning of the weather service in 1870 to the present, new methods for the distribution of forecasts have been tried, many have been abandoned as unsatisfactory or too expensive, and only those retained that assured improvement in placing the information before the public at the earliest possible moment and at the least expense.

The forecasts are now distributed by the daily newspapers, by telegraph, telephone, wireless telegraph, mail (including rural delivery), by display of flags, by whistle signals, and on moving-picture screens.

The following table shows approximately the present wide distribution of weather forecasts in the several States, exclusive of that made by newspapers, daily weather maps, by display of flags, and on moving-picture screens:

Distribution of daily forecasts and special warnings.

State.	At Government expense.			Without expense to Government by—				
	Forecasts and special warnings.	Special warnings only.	Emergency warnings.	Mail.	Rural delivery.	Telephone.	Railroad train service.	Railroad telegraph.
Alabama	24	7	136	1,450	337	43,907	0	10
Arizona	8	1	0	122	0	4.661	0	0
Arkansas	24	9	102	845	562	48,460	0	11
California	84	25	10	2.600	54	0	0	0
Colorado	9	63	41	1.124	1,080	84.300	0	1
Connecticut	5	0	72	2,116	50	75.000	140	0
Delaware	8	1	16	150	300	4,865	0	27
District of Columbia	0	0	0	1.285	0	20.000	0	0
Florida	34	107	52	1.367	225	22.201	0	240
Georgia	49	32	239	1,835	600	58.669	0	161
Idaho	12	0	0	285	200	18.782	0	0
Illinois	113	47	226	3.135	3,264	586.125	0	1
Indiana	93	2	74	2.659	510	239.890	0	0
Iowa	139	8	455	1.850	2,057	243.059	0	0
Kansas	92	2	175	1.721	785	136.383	0	0
Kentucky	69	32	99	1,773	100	54.400	0	0
Louisiana	76	22	48	637	0	32.136	0	18
Maine	11	1	58	1,190	180	24.000	0	0
Maryland	15	49	46	2.248	285	7.900	0	281
Massachusetts	13	13	78	3.158	110	150.000	80	0
Michigan	59	1	0	4.680	719	430.732	181	407
Minnesota	73	3	171	2.384	1,839	159.599	0	13
Mississippi	47	7	59	1,361	1,434	24.900	9	6
Missouri	27	2	236	5,539	0	391.050	0	1
Montana	12	19	13	428	0	19.500	0	5
Nebraska	71	9	205	2,188	420	210,702	0	0

Distribution of daily forecasts and special warnings—Continued.

State.	At Government expense.			Without expense to Government by—				
	Forecasts and special warnings.	Special warnings only.	Emergency warnings.	Mail.	Rural delivery.	Telephone.	Railroad train-service.	Railroad telegraph.
Nevada	5	0	0	57	0	1.200	0	0
New Hampshire	15	0	44	693	775	14.980	15	0
New Jersey	20	17	105	1,484	265	39.064	0	179
New Mexico	8	2	0	135	0	10.500	0	17
New York	109	49	409	9,358	661	735.352	0	118
North Carolina	60	59	187	1,310	1,500	35.00	0	0
North Dakota	25	3	93	500	1,800	15.000	0	150
Ohio	70	147	237	7,291	323	450.000	0	0
Oklahoma	30	1	0	680	343	3.965	0	160
Oregon	10	7	0	492	218	13.000	0	0
Pennsylvania	76	42	315	6,475	1,393	491,700	0	452
Rhode Island	1	0	14	221	0	2,560	13	0
South Carolina	32	11	105	935	375	33.376	0	39
South Dakota	51	9	70	875	7	46.000	0	2
Tennessee	47	3	222	1,867	2,863	65.741	0	0
Texas	85	65	227	1,347	773	201.305	0	0
Utah	6	26	0	212	325	34.106	1	0
Vermont	12	0	54	906	425	22.475	12	0
Virginia	56	6	84	1,730	1,797	26.882	0	44
Washington	22	21	0	847	400	3.551	0	0
West Virginia	34	8	55	994	0	50.969	0	0
Wisconsin	106	6	309	2,653	1,184	67.330	0	0
Wyoming	12	2	13	320	0	6,935	0	0
Totals	2,059	946	5,154	89,512	30,538	5,462,212	451	2,343

Owing to the limited funds available for the purpose the extension of the forecast distribution during recent years has been smaller than it might have been could advantage have been taken of all of the many opportunities that from time to time were presented. The greatest extension has been made through the free distribution by telephone, and it has been by this means that the distribution has been maintained without impairment.

The Weather Bureau has ever been alert to take advantage of every opportunity tending to the betterment of forecast distribution, and is to-day making the forecasts available to more than 5½ million persons, exclusive of those supplied through the daily newspapers, daily weather maps, display of flags, and on moving-picture screens.

SECTION IV.—RIVERS AND FLOODS.

RIVERS AND FLOODS, SEPTEMBER, 1914.

By ALFRED J. HENRY, Professor of Meteorology in charge of River and Flood Division.

[Dated Washington, D. C., Oct. 31, 1914.]

The rivers during September were, as a rule, at low stages, as is characteristic of that month. The rainfall of the month was not sufficient in amount to produce flood stages in any of the larger rivers, but torrential rains caused damaging floods in some of the smaller streams. This fact was strikingly exemplified at Kansas City, Mo., where the heavy rain of the 6th–7th caused an overflow in the valley of Turkey Creek, a small stream that passes through the western suburbs of the city, wrecking and damaging property to the extent of $1,500,000. On account of the intensity of the rainfall and by reason of the tremendous damage that was wrought by what is usually an insignificant stream, it is deemed advisable to reproduce a detailed account of the storm written by Mr. P. Connor, local forecaster, in charge of the Kansas City station.

Torrential rains also fell in eastern Iowa and adjoining localities on the 14th and 15th, but the area of the heavy rains was not great enough to cause a flood in the Mississippi at that point, although an important rise was recorded. Heavy damages were suffered in the city of Dubuque, Iowa, and Galena, Ill., the estimated amounts being $5,000 and $2,000, respectively.

HEAVY RAINSTORM AT KANSAS CITY, MO.

By P. CONNOR, Local Forcaster.

[Dated Weather Bureau, Kansas City, Mo., September, 1914.]

Labor Day was ushered in at Kansas City, Mo., by the greatest rainstorm in any 24-hour period in the history of that station, the rainfall being 7.03 inches, 6.94 inches of which fell in 9 consecutive hours and 46 minutes, from 11:49 p. m. September 6 to 9:35 a. m. of the 7th. The remainder was in sprinkles in the afternoon of the 7th. The damage due to the flood has been estimated at $1,500,000.

The storm was one of a series of closely related thunderstorms due to an area of moderately low barometer over the Southwest, a loop from which extended to northwest Missouri, with pressure nearly two-tenths of an inch higher in the lower Mississippi Valley, and an increasing high in Minnesota and the adjacent territory, diminishing to the northern Rocky Mountain region, but still 0.12 to 0.16 inch higher in Nebraska than in northwest Missouri.

Sunday, September 6, was a moderately warm day; maximum temperature, 90.6°, and humidity, 68. to 70 per cent. The barograph trace showed the actual pressure to be about 28.84 inches (corrected to about 29.88) and stationary. The wind was light and variable, northwest to southwest during most of the forenoon and until 2 p. m., from the south in the afternoon and evening, and southeast to east from 9:15 p. m. until the heavy rain began near midnight. Considerable alto-cumulus and strato-cumulus clouds prevailed during the day. A few local thunderstorms appeared in the north in the afternoon and evening, which passed to the east.

The usual drop in temperature occurred and the barograph trace rose about 0.05 inch. The wind increased to 36 miles an hour at 11:55 for 5 minutes. Scattered raindrops fell from 11:40 p. m. for about 14 minutes, when the downpour began. The heavy rain continued until 12:15 a. m. of the 7th; then with irregular intensity until 12:35 a. m., when it became ordinary light rain until 4 a. m., when it became again decidedly heavy and continued until 9 a. m.; then variable until time of ending at 9:50 a. m. The rainfall to this time was 6.94 inches. The sun came out a few minutes later and shone until nearly noon. Light showers in the afternoon gave 0.09 inch, raising the amount to 7.03 inches.

An excellent record of hourly rainfall was obtained, the following being the amounts:

	Inch.
Sept. 6:	
11.40 to midnight	0.91
Sept. 7:	
Midnight to 1 a. m.	0.84
1 a. m. to 2 a. m.	0.11
2 a. m. to 3 a. m.	0.05
3 a. m. to 4 a. m.	0.05
4 a. m. to 5 a. m.	0.25
5 a. m. to 6 a. m.	0.62
6 a. m. to 7 a. m.	1.86
7 a. m. to 8 a. m.	0.92
8 a. m. to 9 a. m.	1.11
9 a. m. to 9:50 a. m.	0.22
Total	6.94
12 noon to 4:10 p. m.	0.09
Grand total	7.03

Lightning began in the west-southwest about 10:30 p. m., rapidly increasing in frequency. By 11 p. m., or shortly after, the first thunder was heard, and the lightning was flashing over the whole sky. While the thunder was loud at times, it lacked that deep, sonorous quality which makes houses tremble and windows rattle. The lightning struck many objects and buildings and disabled 4,000 telephones. The long-distance telephone lines also suffered greatly.

RAINFALL, FRACTIONS OF AN HOUR.

The greatest amount in 5 minutes was 0.64, which is the greatest in any 5-minute period since the establishment of this station, July 1, 1888. It fell from 11:54 p. m. to 11:59 p. m. of the 6th. The greatest amount in any 10-minute period was 1.01 inches from 11:52 p. m. of the 6th to 12:02 of the 7th. In 15 minutes 1.26 inches fell—from 11:52 p. m. of the 6th to 12:07 a. m. of the 7th. In 1 hour 1.97 inches fell—from 5:55 to 6:55 a. m. of the 7th.

RAINFALL AT NEAREST SUBSTATIONS.

Following is a record of the rainfall at the nearest substations, covering the evening of the 6th and the succeeding day:

Harrisonville	0.33
Maryville	0.56
St. Joseph	1.56
Iola	0.04
Lexington	3.05
Kidder	5.50
Topeka	2.76
Horton	4.14

The rains at Kidder, Mo., and Horton, Kans., show important local development.

DAMAGE CAUSED.

The damage caused in this community by the heavy rain was enormous, being estimated at $1,500,000. It happened chiefly from the approach of the Southwest Boulevard to the West Bottoms through Rosedale, Kans., and the valley of Turkey Creek, a small branch having its source in numerous gullies in Johnson County, Kans., about 30 miles to the west by south of Kansas City. The creek follows a tortuous course through a valley one-fourth to one-half mile in width, bordered by steep hills, and empties into the Kansas River at Nineteenth Street and the State line (in the West Bottoms).

The drainage area of the valley is about 22 square miles. The creek is 12 to 15 feet wide. Nature never intended that such a watercourse should carry off the storm water from that valley. Every extraordinary rain caused an overflow, which ran out with much greater freedom in former years than at present. Commercial necessity, or avarice, has not only claimed part of the original small creek bed, but has actually bridged the stream in several places with buildings; and there are many plank bridges. All of those obstructions held the water back, and as a consequence the flood extended from hillside to hillside.

In the central depression, in which is located the Frisco; Atcheson, Topeka & Santa Fe; and Missouri, Kansas & Texas railroad tracks; and other small industrial plants, the water was 12 feet deep and more. After the water receded the district presented a deplorable appearance. The wreckage of houses, animals, and drift was piled up in great masses, and black, slimy mud was 2 to 3 feet deep in the streets and buildings through which the water ran. The flood carried away the contents of the lumber yard, overturned heavy freight and passenger cars, destroyed long stretches of the railroad tracks, and many of the smaller buildings and manufacturing plants. About 2,000 buildings were damaged and 200 families were left homeless, and 3 lives were lost as a result of the flood. On the Kansas side the damage was about $150,000 to residences and business property and the loss to railroads about $350,000.

EXCESSIVE RAINFALL AT CAMBRIDGE, OHIO, JULY 16, 1914.

On July 16, 1914, 7.09 inches of rain fell at Cambridge, Guernsey County, Ohio, in 1½ hours. It is reported that the rainfall was very local and did not cover an area over 5 miles square. The damage to roads and bridges in the storm area was probably more than $2,500, not including the loss to fields, fences, and farm crops.

MEAN LAKE LEVELS DURING SEPTEMBER, 1914.

By UNITED STATES LAKE SURVEY.

[Dated Detroit, Mich., Oct. 2, 1914.]

The following data are reported in the "Notice to Mariners" of the above date:

Data.	Lakes.			
	Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during September, 1914:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sea level at New York	602.80	580.48	572.37	246.09
Above or below—				
Mean stage of August, 1914	+0.04	−0.16	−0.22	−0.24
Mean stage of September, 1913	−0.03	−0.45	−0.38	−0.65
Average stage for September last 10 years	+0.07	−0.41	−0.07	−0.25
Highest recorded September stage	−1.28	−2.95	−1.57	−1.52
Lowest recorded September stage	+1.31	+0.82	+1.09	+2.09
Probable change during October, 1914	0.0	−0.2	−0.3	−0.3

Below are given the mean lake levels for March and April of the current year. These reports seem to have been lost in the mails when first mailed to this bureau.

MEAN LAKE LEVELS DURING MARCH, 1914.

By UNITED STATES LAKE SURVEY.

[Dated Detroit, Mich., Apr. 2, 1914.]

Data.	Lakes.			
	Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during March, 1914:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sea level at New York	601.91	580.00	571.46	245.67
Above or below—				
Mean stage of February, 1914	−0.27	−0.06	−0.27	−0.20
Mean stage of March, 1913	+0.40	−0.10	−0.99	−1.04
Average stage for March last 10 years	+0.25	−0.14	−0.34	−0.22
Highest recorded March stage	−0.37	−2.95	−2.39	−2.14
Lowest recorded March stage	+1.25	+0.89	+0.63	+1.37
Probable change during April, 1914	0.0	+0.3	+0.7	+0.6

MEAN LAKE LEVELS DURING APRIL, 1914.

By UNITED STATES LAKE SURVEY.

[Dated Detroit, Mich., May 4, 1914.]

Data.	Lakes.			
	Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during April, 1914:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sea level at New York	601.83	580.06	572.10	246.75
Above or below—				
Mean stage of March, 1914	−0.08	+0.06	+0.64	+0.08
Mean stage of April, 1913	+0.19	−0.72	−1.93	−1.11
Average stage for April last 10 years	+0.16	−0.39	−0.42	+0.25
Highest recorded April stage	−0.86	−3.17	−2.08	−1.68
Lowest recorded April stage	+1.29	+0.84	+0.84	+1.91
Probable change during May, 1914	+0.3	+0.3	+0.3	+0.5

SECTION V.—BIBLIOGRAPHY.

RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

C. FITZHUGH TALMAN, Professor in charge of Library.

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

Austria-Hungary. Hydrographisches Zentralbureau.
Jahrbuch, 18. Jahrgang, 1910. Wien. 1913. v. p. f°.

Bonacini, C., & Fabbri, C.
Per lo spoglio dei lanci dei palloni-piloti. Venezia. 1914. 8 p. plate. 4°. (Estratto dal Boll. n. 27 del R. Comitato talassografico italiono.)

Carnet d'enregistrement des dépêches météorologiques transmises par télégraphie sans fil. Avec instructions pratiques pour la lecture et la traduction de ces dépêches. 5e édition. Paris. 1914. unp. 4°.

[Chandler, W. H.]
The killing of plant tissue by low temperature. Columbia, Mo. 1913. 141-309 p. plates. 8°. (Missouri Agric. exper. sta. Research bulletin no. 8.)

Chassigneux, E[dmond].
Les dépressions continentales et le climat du Tonkin. Paris. [1913.] 133 p. 8°. (Revue de géographie, annuelle, t. 7, 1913, fasc. 2.)

Coimbra. Observatorio meteorológico.
Observações meteorológicas, magnéticas e sismicas, 1913, v. 52. Coimbra. 1914. viii, 158 p. f°.

Conrad, V[ictor].
Klimatographie von Kärnten. Wien. 1913. 139 p. map. 4°. (Klimatographie von Österreich, herausg. von der K. K. Zentralanstalt für Meteorologie und Geodynamik. VI.)

Cracow. Observatoryum astronomiczny.
Wyniki spostrzezen meteorologicznych w Galicyi w roku 1913. [Results of meteorological observations made in Galicia in 1913.] [Kraków. 1914.] 61 p. 8°. [Polish.]

Croydon natural history and scientific society.
Report of the Meteorological committee, 1913. (*In* Proc. and trans. of the Society, 1913-14. Croydon. p. 175-186, and app. I-II.)

Dumas, [Jean Baptiste], *& others*.
L'air, l'acide carbonique et l'eau. Paris. 1913. ix, 104 p. 12°. (Les classiques de la science I.)

Great Britain. Meteorological office.
Hourly values from autographic records: Geophysical section, 1912. Terrestrial magnetism, meteorology, and atmospheric electricity. Edinburgh. 1914. 83 p. plate. f°. (Section 2 of part IV of the British meteorological and magnetic year book for 1912.)
Instructions for meteorological telegraphy, in accordance with the international code adopted at Utrecht, September, 1874. (Revised 1910 and 1913.) London. 1914. 49 p. plates. 8°. (M. O. 2, 1914.)
One hundred years of rainfall for London. General fall over the district for each month, 1813-1912. [London. 1913.] chart, 66½ x 82½ cm.

Gutenberg, B.
Über Erdbebenwellen. VII A. Beobachtungen an Registrierungen von Fernbeben in Göttingen und Folgerungen über die Konstitution des Erdkörpers. 52 p. chart. 8°. (Aus den Nachrichten der K. Gesell. der Wissensch. zu Göttingen. Math.-physik. Kl., 1914.)

Hubbard, Thomas.
The air we breath—a study of temperature, humidity and dust contents. 11 p. 8°. (Reprinted from the Laryngoscope, St. Louis, August, 1914.)

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C. FITZHUGH TALMAN, Professor in charge of Library.

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SECTION VI.—WEATHER AND DATA FOR THE MONTH.

THE WEATHER OF THE MONTH.

By P. C. DAY, Climatologist in Charge of Climatological Division.

Pressure.—The distribution of the mean atmospheric pressure over the United States and Canada, and the prevailing directions of the winds are graphically shown on Chart VII, while the average values for the month at the several stations, with the departures from the normal, are shown in Tables I and III.

The barometric pressure for the month as a whole was above the normal over practically the entire country, the plus departures being rather marked in the region of the Great Lakes, the Ohio drainage area, and the Middle Atlantic States. The monthly means were somewhat less than the normal in the central portions of the mountain districts of the West and also in the far Northwest, and as a rule they were near the normal values from the Plains States westward to the Pacific coast.

Pressure changes were active for the season during the first decade of the month. At the beginning a low-pressure area moved from the upper Mississippi Valley to the Canadian Maritime Provinces, and was followed by an extensive, though not intense, area of high barometric pressure which reached the Atlantic coast about the 6th. At this time another cyclonic area had advanced to the Lake region, and a disturbance was also moving inland from the north Pacific Ocean.

At the beginning of the second decade the Lake storm had given way to a marked area of high pressure which covered all eastern districts, and the Northwest low-pressure area had advanced to the Plains region with decreased intensity, but it caused unsettled barometric conditions to the eastward during the following few days. After the middle of the month an extensive area of high pressure persisted in eastern and northeastern districts, with low pressure to the westward, and near the close of the decade a tropical disturbance moved from the South Atlantic coast to the west Gulf States, finally dissipating in the latter locality.

With the exception of a disturbance that moved northeastward from the Gulf and disappeared off the South Atlantic coast during the first few days of the third decade, and low pressure in the same region during the closing days, high pressure dominated the weather in most districts during the last decade of the month, this condition being especially marked in northern districts east of the Mississippi River.

The distribution of the highs and lows was such as to favor the frequent occurrence of northerly winds over most districts east of the Mississippi, while winds from a southerly direction were the rule to the westward, although in the mountain districts the usual variable winds were in evidence.

Temperature.—At the beginning of the month there was a change to warmer weather over all districts to eastward of the Mississippi River, but at the same time cooler weather advanced from the British Northwest and covered the Plains region and upper Mississippi Valley within a few days, being especially cool in the mountain regions of the West, where the minimum temperatures fell to freezing, or slightly lower, at exposed points, and frost occurred in portions of Montana and Wyoming. This cool area rapidly overspread the more eastern sections, but it was followed immediately by warmer weather, and by the 5th maximum temperatures of 100° or higher were recorded at points in the Plains States. However, near the close of the first decade increasing pressure in the Canadian Provinces to northward of the upper Lake region gave cooler weather from the upper Mississippi Valley eastward to New England, frost occurring at exposed points in the region of the Great Lakes.

The cool weather over eastern districts continued during the first half of the second decade, but with a tendency to warmer as the high pressure drifted slowly eastward to the ocean. About the middle of the month a sharp fall in temperature occurred in the northern Rocky Mountain and Plateau regions, but to the eastward warmer weather was the rule, and by the end of the decade temperatures were near or above the seasonal average generally.

Early in the last decade there was a marked increase in pressure over the Mountain regions of the West, with a corresponding sharp fall in temperature, but warm weather continued to eastward of the mountains. The western cool area advanced rapidly and overspread eastern districts, but in the meantime there was a gradual warming up to the westward. Near the end of the month unseasonably cool weather obtained in the Middle Atlantic States and to the northward, the lowest temperature of record for September occurring at points in Virginia and in New England on the morning of the 29th.

The mean temperature for the month as a whole was above the normal from the Mississippi Valley westward to the Plateau region, except in the northern portion of the latter district, and also in the extreme northeast. The largest plus departures, which, however, were not marked, amounting to only slightly more than 3°, appear in the Plains region and portions of the Rocky Mountain district. East of the Mississippi, and in the far West the means for the month were less than the normal, but, like the positive departures, the values were generally small, reaching 3° at only a few points.

Precipitation.—A barometric disturbance that moved from the upper Mississippi Valley over the region of the Great Lakes and down the St. Lawrence Valley during the first few days of the month gave general showers over northern districts to eastward of the Rocky Mountains. Generally fair weather prevailed during the 4th and 5th, but near the end of the first week a second disturbance moved eastward over northern districts, accompanied by unsettled, showery weather over those sections, with heavy local falls at points in the great central valleys, 7.02 inches of rain occurring at Kansas City, Mo., during the 24 hours ending at 8 p. m. of the 7th. Near the end of the decade a low-pressure area moved inland from the north Pacific coast and quite general rains occurred in the far Northwest, largely relieving the droughty conditions that had persisted in that locality.

The northwest rain area advanced rapidly eastward and reached the upper Mississippi Valley early in the second decade, with heavy local falls at points in the Plains region and lower Missouri Valley, and during the following few days unsettled weather was the rule in eastern districts. A disturbance that had moved northward from the Bahama Islands appeared off the east Florida coast on the morning of the 16th, with high northeast winds and rain along the South Atlantic seaboard. During the following few days this storm moved slowly westward, with decreasing intensity, but during this time the rain area had extended northward and westward over the South Atlantic States and most of the Gulf region.

During the first half of the third decade unsettled, showery weather was the rule in districts east of the Rocky Mountains, with some heavy falls in the southeastern States about the 25th, but during the remainder of the month the rainfall was mostly light and local, except for general showers in the east Gulf and South Atlantic States during the closing days, where some further heavy falls occurred.

For the month as a whole the rainfall was heavy, ranging from 6 to 12 inches or more in the middle Mississippi and lower Missouri Valleys, and like amounts occurred also in Florida, while from 6 to 8 inches fell in portions of the other east Gulf States and near the Pacific coast in the far Northwest. With the exception of the sections named, the rainfall for the month was generally light, being markedly deficient in the central and southern portions of the Mountain districts of the West, in the Southwest, and in the central and northern sections east of the Mississippi. The deficiency was especially marked in the States from the Lake region eastward and from Virginia northward to New England, where drought was becoming severe at the close of the month.

GENERAL SUMMARY.

The most noteworthy features of the weather for the month of September, 1914, were the unequal geographic distribution of precipitation, it being excessive in portions of the great central valleys and the southeast and markedly deficient in other large areas, and the persistent cool weather during the first half of the month in northern districts and the unseasonal warmth in those sections during the latter half.

In the great winter-wheat belt moisture was sufficient to maintain the soil in excellent condition, except locally where it was too wet, and the seeding of a large acreage progressed satisfactorily, while in the principal corn-growing States the crop matured without injury from frost.

In the cotton belt some damage occurred from high winds and rain in the central and eastern portions and picking was somewhat delayed, but on the whole the weather was favorable.

In other districts the weather was generally favorable for the maturing of late crops and for fall work, the principal exceptions being the droughty conditions in the Middle and North Atlantic States mentioned elsewhere.

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The temperature for the crop-growing season of 1914 as a whole, March to September, inclusive, was not abnormal, the departures from the normal being within rather moderate bounds, although it was a moderately warm season in the central valleys and the Northwest. However, the precipitation was unevenly distributed geographically, some sections having received much more than the normal amount while in others marked deficiencies are noted, the latter comprising considerable portions of the principal crop-growing sections of the country. The greatest deficiencies in rainfall appear in the central and southern districts east of the Mississippi River and in the Pacific Coast States, notably in California. On the other hand, much of the Plains region and the northern districts from the Rocky Mountains eastward to the Great Lakes, as well as the greater portion of Texas, received much more than the normal amount of rainfall for the season.

Average accumulated departures for September, 1914.

Districts.	Temperature.			Precipitation.			Cloudiness.		Relative humidity.	
	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure from the normal.	General mean for the current month.	Departure from the normal.
	°F.	°F.	°F.	Inches	Inches	Inches.			P.ct.	
New England	61.2	+0.5	− 9.0	1.02	−1.10	− 3.90	4.3	−0.9	73	−8
Middle Atlantic	64.8	−1.4	− 2.5	0.89	−2.40	− 5.80	3.8	−0.8	71	−6
South Atlantic	71.6	−1.6	+ 2.6	3.53	−1.20	−12.00	5.2	+0.5	78	−2
Florida Peninsula	79.7	−1.0	− 3.6	5.87	−2.10	−13.80	5.9	+0.5	78	−3
East Gulf	74.4	−0.4	− 2.8	5.27	+1.40	− 4.10	4.8	+0.2	78	+2
West Gulf	77.5	−1.8	+ 5.7	2.28	−1.20	− 5.00	3.3	−0.9	74	0
Ohio Valley and and Tennessee	67.6	−0.6	+ 2.1	1.66	−1.10	− 6.70	4.3	−0.1	72	0
Lower Lakes	61.7	−1.5	− 7.8	1.72	−1.10	− 0.90	4.2	−0.6	71	−2
Upper Lakes	59.9	+0.8	+ 3.7	2.28	−0.90	+ 0.20	4.7	−0.5	79	+2
North Dakota	59.6	+2.4	+14.2	1.16	−0.30	+ 2.90	3.9	−0.5	70	+4
Upper Mississippi Valley	65.7	+0.9	+14.9	5.25	+1.90	− 3.30	4.5	+0.2	78	+6
Missouri Valley	67.4	+2.1	+20.7	5.23	+2.40	− 0.60	4.2	+0.2	71	+5
Northern slope	58.0	+0.7	+16.3	1.03	−0.10	− 1.70	4.3	+0.3	58	+3
Middle slope	71.0	+3.4	+20.3	1.79	−0.20	− 3.60	3.3	−0.1	62	+4
Southern slope	74.7	+1.9	+ 7.6	0.66	−1.90	+ 2.50	2.6	−1.2	62	−1
Southern Plateau	72.1	+1.5	+ 3.4	0.27	−0.60	− 1.20	2.7	+0.2	46	+7
Middle Plateau	61.8	+0.2	+ 9.4	0.31	−0.50	− 0.30	3.1	+0.2	39	+1
Northern Plateau	59.1	−2.1	+16.4	1.15	−0.20	− 1.10	4.6	+1.0	50	−2
North Pacific	55.9	−1.0	+12.2	3.09	+0.70	+ 0.40	7.0	+1.7	81	+9
Middle Pacific	61.9	−1.5	+ 4.9	0.32	−0.30	− 0.70	3.2	−0.2	61	−6
South Pacific	67.1	−0.2	+12.8	0.06	−0.20	+ 3.60	2.9	+0.3	67	−1

Maximum wind velocities, September, 1914.

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
		mi./hr.				mi./hr.	
Buffalo, N. Y.	3	60	sw.	New York, N. Y.	7	52	nw.
Do	27	50	w.	Do	30	54	nw.
Cheyenne, Wyo.	12	60	w.	North Head, Wash.	17	58	se.
Do	14	50	w.	Do	18	92	se.
Hatteras, N. C.	25	52	n.	Pittsburgh, Pa.	2	53	nw.
Havre, Mont.	18	50	w.	Point Reyes Light, Cal.	6	52	nw.
Lander, Wyo.	15	64	sw.	Do	7	50	nw.
Modena, Utah	15	52	s.	Do	11	68	nw.
Mount Tamalpais, Cal.	6	52	nw.	Do	12	66	nw.
Do	7	52	nw.	Do	26	54	nw.
Do	8	52	nw.	Tatoosh Island, Wash.	27	52	s.
Do	15	56	nw.				

CONDENSED CLIMATOLOGICAL SUMMARY.

In the following table are given for the various sections of the climatological service of the Weather Bureau: the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data, as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation and the greatest and least monthly amounts, are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course the number of such records is smaller that the total number of stations.

Summary of temperature and precipitation, by sections, September, 1914.

Section.	Temperature (°F.).								Precipitationin (inches and hundredths).					
			Monthly extremes.								Greatest monthly.		Least monthly.	
	Section average.	Departure from the normal.	Station.	Highest.	Date.	Station.	Lowest.	Date.	Section average.	Departure from the normal.	Station.	Amount.	Station.	Amount.
Alabama	72.4	−2.5	2 stations	100	1†	Cordova	42	25	4.69	+1.14	Robertsdale	15.39	Cullman	0.75
Arizona	74.8	+1.9	Quartzsite	111	19	2 stations	28	14†	0.79	−0.28	Pinal Ranch	4.67	4 stations	0.00
Arkansas	74.4	+1.1	Lewisville	101	9†	Dutton	38	24	3.19	−0.24	Brinkley	10.61	Fulton	0.41
California	66.2	−2.3	2 stations	112	11†	Macdoel	15	15	0.23	−0.26	Crescent City	8.11	107 stations	0.00
Colorado	59.3	+2.3	Lamar	104	4	Lay	10	14	0.71	−0.70	Platoro	3.60	2 stations	0.00
Florida	77.8	−1.4	Apalachicola	100	9	Wausau	50	14†	7.29	+0.37	Garniers (near)	13.14	Grasmere	2.42
Georgia	72.7	−2.1	Dublin	100	8	Blue Ridge	38	27	3.53	−0.16	Thomasville	7.58	Hartwell	0.69
Hawaii (August)	75.1	......	4 stations	92	13†	Volcano House, Hawaii.	52	22	13.91	......	Honomu, Hawaii	84.41	2 stations	0.00
Idaho	55.5	−1.6	2 stations	100	2†	Kilgore	14	10	1.64	+0.75	Burke	4.09	Glenns Ferry	0.14
Illinois	66.8	−0.4	Carbondale	95	1†	Sycamore	34	26	3.82	+0.46	Lanark	8.44	Charleston	1.05
Indiana	66.2	−1.2	Hammond	99	2	Collegeville	33	26	2.34	−0.66	Decker	5.07	Connersville	0.68
Iowa	64.5	+1.1	2 stations	99	5	Washta	30	4	7.88	+4.52	Lenox	16.24	Lake Park	2.48
Kansas	72.1	+3.0	Scott City	107	5	3 stations	35	23†	2.84	+0.01	Horton	11.37	Coolidge	0.00
Kentucky	67.8	−2.8	Beattyville	97	21	2 stations	36	26†	2.96	+0.26	Blandville	6.04	Farmers	1.03
Louisiana	77.3	−0.3	Angola	105	10	Cameron	42	25	2.85	−1.15	Lawrence	7.15	Shreveport	0.15
Maryland & Delaware	64.8	−3.0	3 stations	98	21†	Deer Park, Md.	21	29	0.93	−2.24	Keedysville, Md	3.09	Seaford, Del	0.40
Michigan	60.1	0.0	2 stations	93	20†	Watersmeet	23	8†	2.27	−0.60	Bloomingdale	10.67	East Tawas	0.51
Minnesota	60.0	−1.4	Warren	93	19	3 stations	26	25†	3.08	−0.14	St. Cloud	6.49	Crookston	0.67
Mississippi	74.7	−0.6	Hazelhurst	100	8	Duck Hill	42	26	4.43	+0.87	Waynesboro	12.32	Natchez	0.78
Missouri	69.6	+0.5	2 stations	99	5	Cassville	35	26	6.27	+2.52	Kansas City	16.17	Hollister	2.20
Montana	55.7	−0.4	Fallon	100	17	Lima	9	13	1.48	−0.03	Belton	4.80	Augusta	T.
Nebraska	65.4	+1.7	Weeping Water	105	5	Mitchell	23	14	2.18	+0.07	Falls City	13.77	3 stations	0.00
Nevada	58.9	−0.8	Logan	103	18†	Potts	17	13†	0.45	−0.10	Columbia	1.79	2 stations	0.00
New England	60.2	+0.1	3 stations	97	22	Norfolk, Mass	18	29	0.98	−2.55	Van Buren, Me	4.07	Concord, Mass	0.12
New Jersey	64.0	−1.6	....do	99	22	2 stations	24	29	0.37	−3.58	Woodbine	1.64	Belvidere	0.14
New Mexico	65.7	+0.9	Artesia	102	7	Elizabethtown	22	24	0.67	−0.80	Mountain Park	2.92	4 stations	0.00
New York	59.6	−1.5	Wappingers Falls	99	22	Lake Placid Club	18	29	1.51	−1.86	Dannemora	3.41	New York City	0.20
North Carolina	68.1	−2.6	Greensboro	99	2	Banners Elk	32	27	3.16	−0.47	Bolton	9.19	Andrews	0.90
North Dakota	59.3	+2.9	2 stations	98	18	3 stations	25	22	1.06	−0.56	Wahpeton	3.14	McKinney	0.28
Ohio	63.4	−2.2	3 stations	97	21†	Lisbon	26	28	1.41	−1.28	Montpelier	3.42	Killbuck	0.65
Oklahoma	75.3	+1.6	Hooker	106	7	Kenton	35	24	2.15	−0.31	Whiteagle	7.61	2 stations	T.
Oregon	56.7	−1.7	Blalock	98	24	Whitaker	9	27	3.21	+1.45	Happy Home	13.56	Diamond	0.05
Pennsylvania	61.5	−2.5	Lock Haven	98	22	West Bingham	21	28	0.99	−2.27	Irwin	2.67	Center Hall	0.03
Porto Rico	79.1	+0.3	2 stations	98	14†	Aibonito	51	10†	4.99	−3.10	Anasco	17.35	San German	0.20
South Carolina	71.3	−2.9	Blackville	101	8	5 stations	43	11†	3.63	−0.41	Georgetown	7.55	Liberty	1.45
South Dakota	63.1	+1.7	Oelrichs	104	19	Oelrichs	23	14	2.09	+1.06	Vermillion	6.50	Daviston	0.40
Tennessee	70.3	−0.5	Pinewood	101	2	Mountain City	33	27	2.53	−0.41	Union City	9.26	Lebanon (near)	0.99
Texas	77.3	+0.1	San Juanito	105	18	Midland	35	30	1.46	−1.46	Brighton	5.25	3 stations	0.00
Utah	61.1	−0.1	St. George	100	19	Scofield	18	14	0.48	−0.57	Silver City	2.11	Morgan	0.00
Virginia	65.8	−2.3	Petersburg	100	2	Burkes Garden	28	27	1.65	−1.69	Diamond Springs	3.12	Dale Enterprise	0.51
Washington	56.5	−1.5	Eltopia	95	2	Deer Park	25	12	2.63	+0.77	Lake Cushman	12.21	Eltopia	0.01
West Virginia	63.2	−3.1	2 stations	97	1†	Bayard	24	29	1.58	−1.33	Nuttallburg	5.65	Beckley	0.17
Wisconsin	59.9	0.0	3 stations	90	19†	Glen Flora	25	25	3.97	+0.48	Shullsburg	9.95	Hayward	1.27
Wyoming	53.9	+1.1	Colony	98	30	Willow Creek	12	13†	0.82	−0.35	Moran	3.28	Hyattville	0.00

† Other dates also.

DESCRIPTION OF TABLES AND CHARTS.

Table I gives the data ordinarily needed for climatological studies for about 158 Weather Bureau stations making simultaneous observations at 8 a. m. and 8 p. m., seventy-fifth meridian time daily, and for about 41 others making only one observation. The altitudes of the instruments above ground are also given.

Table II gives a record of precipitation, the intensity of which at some period of the storm's continuance equaled or exceeded the following rates:

Duration (minutes)	5	10	15	20	25	30	35	40	45	50	60
Rates per hour (inches)	3.00	1.80	1.40	1.20	1.08	1.00	0.94	0.90	0.87	0.84	0.80

It is impracticable to make this table sufficiently wide to accommodate on one line the record of accumulated falls that continue at an excessive rate for several hours. In this case *the record is broken at the end of each 50 minutes*, the accumulated amounts being recorded on successive lines until the excessive rate ends.

In cases where no storm of sufficient intensity to entitle it to a place in the full table has occurred, the greatest precipitation of any single storm has been given, also the greatest hourly fall during that storm.

Table III gives, for about 30 stations of the Canadian Meteorological Service, the means of pressure and temperature, total precipitation and depth of snowfall, and the respective departures from normal values, except in the case of snowfall.

Chart I.—Hydrographs for several of the principal rivers of the United States.

Chart II.—Tracks of centers of high areas; and

Chart III.—Tracks of centers of low areas. The roman numerals show the chronological order of the centers. The figures within the circles show the days of the month; the letters *a* and *p* indicate, respectively, the observations at 8 a. m. and 8 p. m., seventy-fifth meridian time. Within each circle is also given (Chart II) the last three figures of the highest barometric reading and (Chart III)

the lowest reading reported at or near the center at that time, and in both cases as reduced to sea level and standard gravity.

Chart IV.—Temperature departures. This chart presents the departures of the monthly mean temperatures from the monthly normals. The normals used in computing the departures were computed for a period of 31 years (1883 to 1903) and are published in Weather Bureau Bulletin "R," Washington, 1908. The shaded portions of the chart indicate areas of positive departures and unshaded portions indicate areas of negative departures. Generalized lines connect places having approximately equal departures of like sign. This chart of monthly temperature departures in the United States was first published in the Monthly Weather Review for July, 1909.

Chart V.—Total precipitation. The scale of shades showing the depth is given on the chart. Where the monthly amounts are too small to justify shading, and over sections of the country where stations are too widely separated or the topography is too diversified to warrant reasonable accuracy in shading, the actual depths are given for a limited number of representative stations. Amounts less than 0.005 inch are indicated by the letter T, and no precipitation by 0.

Chart VI.—Percentage of clear sky between sunrise and sunset. The average cloudiness at each Weather Bureau station is determined by numerous personal observations between sunrise and sunset. The difference between the observed cloudiness and 100 is assumed to represent the percentage of clear sky, and the values thus obtained are the basis of this chart. The chart does not relate to the nighttime.

Chart VII.—Isobars and isotherms at sea level and prevailing wind directions. The pressures have been reduced to sea level and standard gravity by the method described by Prof. Frank H. Bigelow on pages 13–16 of the REVIEW for January, 1902. The pressures have also been reduced to the mean of the 24 hours by the application of a suitable correction to the mean of the 8 a. m. and 8 p. m. readings at stations taking two observations daily, and to the 8 a. m. or the 8 p. m. observations, respectively, at stations taking but a single observation. The diurnal corrections so applied will be found in the Annual Report of the Chief of the Weather Bureau, 1900–1901, volume 2, Table 27, pages 140–164.

The isotherms on the sea level plane have been constructed by means of the data summarized in chapter 8 of volume 2 of the annual report just mentioned. The correction t_0–t, or temperature on the sea-level plane minus the station temperature as given by Table 48 of that report, is added to the observed surface temperature to obtain the adopted sea-level temperature.

The prevailing wind directions are determined from hourly observations at the great majority of the stations; a few stations having no self-recording wind direction apparatus determine the prevailing direction from the daily or twice-daily observations only.

Chart VIII.—Total snowfall. This is based on the reports from regular and cooperative observers and shows the depth in inches and tenths of the snowfall during the month. In general, the depth is shown by lines inclosing areas of equal snowfall, but in special cases figures are also given.

Chart VIII is published only when the general snow cover is sufficiently extensive to justify its preparation

TABLE I.—*Climatological data for United States Weather Bureau stations, September, 1914.*

Districts and stations.	Elevation of instruments: Barometer above sea level, feet.	Elevation of instruments: Thermometer above ground.	Elevation of instruments: Anemometer above ground.	Pressure, in inches: Station, reduced to mean of 24 hours.	Pressure, in inches: Sea level, reduced to mean of 24 hours.	Pressure, in inches: Departure from normal.	Temperature: Mean max. + mean min. ÷ 2.	Temperature: Departure from normal.	Temperature: Maximum.	Temperature: Date.	Temperature: Mean maximum.	Temperature: Minimum.	Temperature: Date.	Temperature: Mean minimum.	Temperature: Greatest daily range.
New England.							**61.2**	**+ 0.5**							
Eastport	76	67	85	29.96	30.04	+0.01	57.7	+ 2.5	81	22	66	35	29	50	29
Greenville	1,070	6		28.91	30.07		56.8		89	23	67	28	29	47	34
Portland, Me.	103	82	117	29.97	30.09	+ .04	61.3	+ 1.7	92	22	71	32	29	52	29
Concord	288	70	79	29.79	30.10	+ .04	59.2	+ 0.1	92	22	72	26	29	46	44
Burlington	404	11	48	29.68	30.11	+ .05	58.0	− 0.9	89	21	68	25	29	48	35
Northfield	876	12	60	29.19	30.14	+ .08	54.6	0.0	89	22	68	20	29	41	44
Boston	125	115	188	29.96	30.09	+ .02	64.6	+ 1.9	94	23	74	34	29	55	28
Nantucket	12	14	90	30.08	30.09	+ .01	63.5	+ 0.7	86	21	70	43	29	57	26
Block Island	26	11	46	30.07	30.10	+ .02	62.8	− 1.3	83	21	69	38	29	56	21
Narragansett Pier		9					61.6	− 1.2	88	21	72	32	29	52	30
Providence	160	215	251	29.93	30.11	+ .04	63.5	+ 0.3	89	21	74	33	29	54	30
Hartford	159	122	140	29.94	30.11	+ .04	63.2	+ 1.5	93	23	75	32	29	51	36
New Haven	106	117	155	30.00	30.12	+ .05	64.4	+ 0.5	92	21	75	35	29	54	34
Middle Atlantic States.							**64.8**	**− 1.4**							
Albany	97	102	115	30.02	30.12	+ .05	62.6	+ 0.3	92	22	74	32	29	51	35
Binghamton	871	10	69	29.22	30.15	+ .08	59.8	− 0.2	91	22	72	31	29	48	38
New York	314	414	454	29.78	30.11	+ .03	66.2	− 0.3	92	22	75	42	28	57	29
Harrisburg	374	94	104	29.76	30.16	+ .08	64.4	− 0.5	92	23	75	38	29	54	31
Philadelphia	117	123	190	30.02	30.15	+ .07	67.2	− 0.2	93	21	77	44	29	58	31
Reading	325	81	98	29.80	30.15		64.2		92	22	76	37	29	53	35
Scranton	805	111	119	29.30	30.16	+ .09	60.9	− 1.3	93	22	73	34	29	49	38
Atlantic City	52	37	48	30.08	30.13	+ .06	65.3	− 2.3	86	22	72	42	28	58	22
Cape May	18	13	49	30.14	30.16	+ .09	65.5	− 3.5	87	7	73	42	29	58	23
Trenton	190	159	183	29.92	30.12		65.2		95	22	76	39	29	54	34
Baltimore	123	100	113	30.02	30.15	+ .07	66.8	− 1.8	94	2	76	45	28	58	28
Washington	112	62	85	30.02	30.14	+ .06	66.0	− 2.1	96	2	77	41	29	55	34
Lynchburg	681	153	188	29.41	30.15	+ .07	66.7	− 1.7	93	2	78	39	29	55	38
Mount Weather	1,725	10	75	28.34	30.14	+ .07	61.4	− 1.0	86	22	70	38	28	53	23
Norfolk	91	170	205	30.04	30.14	+ .08	69.4	− 2.3	92	2	77	51	29	62	28
Richmond	144	11	52	30.00	30.15	+ .08	68.2	− 2.6	98	2	79	41	29	57	33
Wytheville	2,293	40	47	27.80	30.15	+ .08	62.4	− 1.2	86	21	74	36	27	51	34
South Atlantic States.							**71.6**	**− 1.6**							
Asheville	2,255	70	84	27.83	30.15	+ .08	65.1	+ 0.1	86	1	75	40	27	55	31
Charlotte	773	68	76	29.31	30.15	+ .08	69.2	− 1.5	92	2	78	49	27	60	26
Hatteras	11	12	50	30.10	30.11	+ .05	72.0	− 2.7	87	8	77	56	30	67	19
Manteo	12	4	46				70.6		91	7	79	42	29	62	
Raleigh	376	103	110	29.74	30.13	+ .06	68.9	− 1.7	93	2	78	48	27	60	26
Wilmington	78	81	91	30.04	30.12	+ .07	70.8	− 2.3	92	8	80	50	29	62	24
Charleston	48	11	92	30.04	30.09	+ .05	74.4	− 1.8	92	8	81	57	26	68	18
Columbia, S.C.	351	41	57	29.75	30.13	+ .08	71.0	− 2.7	94	7	80	51	26	62	24
Augusta	180	89	97	29.92	30.11	+ .06	72.5	− 1.9	95	8	82	52	28	63	29
Savannah	65	150	194	30.01	30.08	+ .05	74.5	− 0.9	94	8	82	55	26	68	23
Jacksonville	43	96	129	30.00	30.05	+ .05	77.2	− 0.1	94	9	84	60	26	70	21
Florida Peninsula.							**79.7**	**− 1.0**							
Key West	22	10	64	29.95	29.97	+ .03	82.0	− 0.5	90	1	87	71	22	77	17
Miami	25	71	79	29.97	30.00		78.8	− 2.7	87	25	84	69	15	74	15
Sand Key	23	39	72	29.93	29.96	+ .02	80.2		88	12	84	70	6	77	16
Tampa	35	79	96	29.98	30.01	+ .04	78.4	+ 0.1	92	1	87	65	11	70	24
Titusville	44	6													
East Gulf States.							**74.4**	**− 0.4**							
Atlanta	1,174	190	216	28.90	30.12	+ .07	71.4	− 0.7	90	7	80	54	27	63	22
Macon	370	78	87	29.70	30.09	+ .06	72.7	− 0.2	94	8	82	54	28	63	29
Thomasville	273	8	57	29.75	30.04	+ .03	75.3	− 1.5	96	8	85	57	26	66	29
Pensacola	56	140	182	29.97	30.03	+ .04	76.4	− 1.5	93	9	83	58	25	70	21
Anniston	741	9	57	29.34	30.12	+ .09	71.6	+ 0.3	93	1	82	47	26	61	33
Birmingham	700	11	48	29.35	30.11	+ .08	72.5	− 1.5	92	8	82	49	26	63	29
Mobile	57	125	161	29.97	30.03	+ .03	76.8	+ 0.3	96	9	85	57	25	69	22
Montgomery	223	100	112	29.83	30.08	+ .06	74.2	− 1.6	93	8	83	54	26	65	27
Meridian	375	85	93	29.67	30.06	+ .04	73.2	+ 0.5	92	9	83	51	25	63	30
Vicksburg	247	65	74	29.79	30.07	+ .05	75.6	+ 0.8	92	9	84	55	24	67	26
New Orleans	51	90	121	29.96	30.01	+ .03	78.8	+ 0.8	94	10	85	63	24	72	19
West Gulf States.							**77.5**	**+ 1.8**							
Shreveport	249	77	93	29.78	30.05	+ .05	77.2	+ 1.5	96	11	87	51	24	68	27
Bentonville	1,303	11	44	28.72	30.06	+ .04	72.2	+ 3.3	90	8	82	46	23	62	30
Fort Smith	457	79	94	29.56	30.04	+ .03	76.0	+ 3.3	94	5	86	50	24	66	30
Little Rock	357	139	147	29.70	30.07	+ .04	74.6	+ 1.5	94	6	83	52	24	66	26
Brownsville	57	3	40				80.9		97	16	92	58	25	70	31
Corpus Christi	20	69	77	29.98	30.00	+ .05	80.7	+ 1.7	94	18	87	61	24	74	23
Dallas	512	109	117	29.50	30.04	+ .05	78.0		94	11	88	51	24	68	29
Fort Worth	670	106	114	29.30	30.01	+ .02	77.4	+ 0.7	96	11	87	53	27	67	27
Galveston	54	106	114	29.97	30.03	+ .05	80.2	+ 0.8	89	2	85	63	24	76	14
Houston	138	111	121	29.88	30.02		79.2	+ 0.7	95	1	88	58	24	70	25
Palestine	510	64	72	29.49	30.02	+ .03	77.8	+ 3.1	95	4	87	54	27	68	25
San Antonio	701	109	132	29.29	30.01	+ .05	79.6	+ 2.5	95	11	90	57	24	69	28
Taylor	582	55	62	29.44	30.06	+ .09	77.6	+ 0.7	94	9	88	53	27	67	28

Districts and stations.	Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity, per cent.	Precipitation, inches: Total.	Precipitation: Departure from normal.	Precipitation: Days with 0.01 or more.	Wind: Total movement, miles.	Wind: Prevailing direction.	Wind: Maximum velocity: Miles per hour.	Wind: Maximum velocity: Direction.	Wind: Maximum velocity: Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
New England.			**73**	**1.02**	**− 1.1**										**4.3**		
Eastport	52	49	78	2.92	0.0	9	5,160	s.	24	n.	28	11	10	9	5.2		
Greenville				2.68		13											
Portland, Me.	53	48	67	0.73	− 2.5	5	5,597	n.	27	nw.	26	15	7	8	4.4		
Concord				0.21	− 3.0	4	2,830	nw.	21	w.	7	15	8	7	3.9		
Burlington				2.36	− 1.0	15	5,857	s.	32	s.	6	9	8	13	5.8		
Northfield	50	48	88	2.04	− 0.7	13	3,898	s.	28	s.	6	11	5	14	5.7		
Boston	57	52	69	0.21	− 3.0	4	6,505	nw.	29	w.	7	20	5	5	3.5		
Nantucket	58	55	78	1.61	− 1.1	4	10,100	sw.	42	n.	26	15	11	4	4.4		
Block Island	57	54	75	0.29	− 2.7	4	10,792	sw.	48	w.	3	16	12	2	3.4		
Narragansett Pier				1.01		3		sw.				25	4	1			
Providence	56	50	67	0.48	− 2.7	5	7,894	nw.	40	nw.	7	17	11	2	3.4		
Hartford	55	50	68	0.20	− 3.3	4	4,331	s.	25	s.	6	15	8	7	4.1		
New Haven	56	51	66	0.17	− 3.6	4	5,821	n.	29	nw.	26	16	11	3	3.3		
Middle Atlantic States.			**71**	**0.89**	**− 2.4**										**3.8**		
Albany	54	50	73	0.47	− 2.7	5	4,128	s.	26	sw.	2	17	9	4	3.3		
Binghamton				1.11	− 1.7	6	3,039	nw.	22	nw.	2	14	10	6	4.3		
New York	57	51	63	0.20	− 3.4	2	10,686	nw.	54	nw.	30	14	12	4	4.0		
Harrisburg	56	51	69	0.68	− 2.2	7	3,348	w.	22	w.	23	16	10	4	3.6		
Philadelphia	57	52	63	0.86	− 2.5	3	6,573	nw.	30	nw.	24	19	6	5	3.5		
Reading	55	50	66	0.43	− 3.2	3	3,748	n.	25	w.	7	12	13	5	4.3		
Scranton	55	52	80	1.05	− 1.8	8	3,793	n.	30	sw.	23	14	13	3	3.7		
Atlantic City	59	55	72	0.26	− 2.8	4	5,676	sw.	21	ne.	13	20	5	5	3.6		
Cape May				0.46	− 2.5	4	5,756	n.	26	e.	12	15	12	3	3.5		
Trenton	56	51	66	0.41	− 3.2	2	7,299	n.	33	n.	26	17	10	3	3.5		
Baltimore	58	53	66	1.64	− 2.2	6	4,704	n.	27	n.	24	20	5	5	3.1		
Washington	58	54	74	0.66	− 2.9	4	3,634	n.	28	nw.	24	15	9	6	4.0		
Lynchburg	59	55	75	0.67	− 3.0	7	4,096	ne.	22	ne.	16	17	6	7	4.5		
Mount Weather	54	50	70	0.90	− 2.0	6	9,185	nw.	37	nw.	4	11	12	7	4.5		
Norfolk	62	59	76	2.97	− 1.1	8	9,440	ne.	43	nw.	3	12	11	7	4.7		
Richmond	59	55	70	1.47	− 2.0	7	5,205	ne.	27	nw.	24	16	9	5	3.6		
Wytheville	56	54	85	0.94	− 2.4	7	2,325	e.	15	nw.	4	19	8	3	2.9		
South Atlantic States.			**78**	**3.53**	**− 1.2**										**5.2**		
Asheville	58	55	80	2.09	− 1.0	10	4,718	se.	33	e.	17	7	18	5	5.1		
Charlotte	61	57	73	2.02	− 1.2	8	4,485	ne.	20	ne.	16	12	6	12	5.3		
Hatteras	67	64	79	3.33	− 2.0	8	9,324	ne.	52	n.	25	12	10	8	5.0		
Manteo				2.44	− 2.9	3		ne.				20	6	4			
Raleigh	61	58	76	4.29	+ 1.0	8	5,244	ne.	24	ne.	16	13	9	8	4.7		
Wilmington	64	62	82	5.39	+ 0.1	7	5,336	ne.	31	e.	17	13	10	7	4.7		
Charleston	68	65	77	4.69	− 0.8	7	7,999	ne.	45	e.	17	13	7	10	4.9		
Columbia, S.C.	63	60	76	2.60	− 0.8	9	4,769	ne.	24	ne.	17	12	9	9	4.3		
Augusta	65	62	76	2.48	− 1.2	6	4,491	ne.	31	ne.	16	13	4	13	5.2		
Savannah	68	66	82	3.07	− 2.5	8	6,844	ne.	30	n.	16	6	12	12	6.4		
Jacksonville	70	68	81	6.39	− 1.6	12	7,349	ne.	34	sw.	17	7	8	15	6.6		
Florida Peninsula.			**78**	**5.87**	**− 2.1**										**5.9**		
Key West	75	73	76	4.62	− 2.2	15	6,451	e.	39	w.	25	6	18	6	4.9		
Miami	74	72	80	6.68	− 2.9	20	6,256	e.	32	e.	1	2	14	14	7.0		
Sand Key	76	73	77	6.09		16	8,947	e.	39	e.	22	9	16	5	4.8		
Tampa	71	69	81	6.30	− 1.1	16	5,484	ne.	49	sw.	1	2	16	12	6.9		
Titusville																	
East Gulf States.			**78**	**5.27**	**+ 1.4**										**4.8**		
Atlanta	63	59	72	2.48	− 1.0	9	6,172	e.	34	se.	18	13	4	13	5.2		
Macon	65	62	75	4.39	+ 1.0	7	4,399	ne.	28	ne.	17	12	9	9	4.7		
Thomasville	68	66	83	7.58	+ 3.3	13	3,643	ne.	19	ne.	29	10	8	12	5.6		
Pensacola	69	66	78	11.93	+ 6.7	11	9,324	ne.	48	e.	30	10	6	14	5.8		
Anniston				3.30	− 0.2	7	3,810	se.	25	se.	13	15	9	6	4.4		
Birmingham	64	61	77	3.95	+ 0.4	12	4,084	e.	20	nw.	8	12	7	11	5.0		
Mobile	69	67	79	7.96	+ 2.9	13	7,214	ne.	48	e.	29	12	13	5	4.3		
Montgomery	66	62	74	2.95	+ 0.1	8	4,684	e.	26	n.	11	13	8	9	4.9		
Meridian	66	64	80	3.95	+ 0.5	10	3,751	ne.	18	ne.	28	12	9	9	4.9		
Vicksburg	68	65	78	4.39	+ 1.0	7	4,306	e.	18	s.	21	19	3	8	3.5		
New Orleans	72	69	80	5.05	+ 0.2	10	5,583	ne.	38	n.	3	11	13	6	4.4		
West Gulf States.			**74**	**2.28**	**− 1.2**										**3.3**		
Shreveport	69	66	74	0.15	− 3.1	2	4,459	se.	21	ne.	30	17	9	4	3.6		
Bentonville				2.40	− 1.1	7	3,754	s.	26	n.	2	17	11	2	3.3		
Fort Smith	67	64	73	2.89	− 0.3	6	5,212	e.	35	n.	2	16	11	3	3.2		
Little Rock	67	64	77	1.93	− 1.3	8	5,505	e.	26	se.	4	13	7	10	4.5		
Brownsville				0.86		6		se.									
Corpus Christi	73	71	80	2.76	− 1.2	2	8,849	se.	44	n.	23	16	11	3	3.9		
Dallas				2.09		2	6,189	se.	37	n.	22	22	6	2	2.8		
Fort Worth	67	63	68	1.61	− 1.3	2	6,549	s.	31	s.	14	18	9	3	2.9		
Galveston	72	68	71	5.20	− 0.2	7	7,661	s.	35	ne.	24	23	5	2	2.8		
Houston				1.21		8	4,987	se.	27	se.	3	15	12	3	3.7		
Palestine	68	65	75	2.04	− 1.2	5	4,668	s.	29	s.	21	21	6	3	3.1		
San Antonio	69	65	70	2.24	− 0.7	4	5,048	ne.	33	n.	22	16	14	0	3.1		
Taylor				1.53	− 1.5	4	5,098	s.	25	n.	22	19	9	2	3.2		

TABLE I.—*Climatological data for United States Weather Bureau stations, September, 1914*—Continued.

Districts and stations.	Elevation of instruments. Barometer above sea level, feet.	Thermometer above ground.	Anemometer above ground.	Pressure, in inches. Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Temperature of the air, in degrees Fahrenheit. Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity, per cent.	Precipitation, inches. Total.	Departure from normal.	Days with 0.01 or more.	Wind. Total movement, miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Direction.	Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
Ohio Valley and Tennessee.							**67.6**	**− 0.6**										**72**	**1.66**	**− 1.1**										**4.3**		
Chattanooga	762	189	213	29.33	30.14	+ .08	71.3	+ 0.1	93	1	81	48	27	62	30	62	58	70	1.67	− 1.6	7	4,441	ne.	24	n.	25	8	15	7	5.3	.....	.....
Knoxville	996	93	100	29.08	30.13	+ .07	70.0	+ 0.6	90	1	80	47	27	60	30	62	59	73	1.04	− 1.8	5	2,873	ne.	18	n.	25	9	12	9	5.4	.....	.....
Memphis	399	76	97	29.69	30.12	+ .09	73.8	+ 1.0	92	7	82	50	24	66	24	66	63	74	3.92	+ 0.9	8	4,738	ne.	32	w.	11	14	7	9	4.5	.....	.....
Nashville	546	168	191	29.55	30.13	+ .07	71.0	+ 0.5	90	1	81	48	27	61	29	63	60	75	1.46	− 2.2	4	5,169	ne.	26	se.	18	10	14	6	4.8	.....	.....
Lexington	989	75	102	29.08	30.14	+ .07	66.8	− 1.1	90	21	76	46	26	57	25	.....	.....	.....	1.82	− 0.6	6	5,597	ne.	27	nw.	6	16	10	4	3.7	.....	.....
Louisville	525	219	255	29.57	30.15	+ .09	69.0	− 0.9	90	21	78	48	27	60	28	61	57	72	1.35	− 1.3	6	6,453	ne.	32	s.	22	15	6	9	4.0	.....	.....
Evansville	431	72	82	29.66	30.12	+ .06	69.6	− 0.1	89	1	79	49	27	60	27	62	58	74	5.06	+ 2.4	7	4,480	ne.	23	s.	1	14	9	7	4.2	.....	.....
Indianapolis	822	154	164	29.26	30.15	+ .09	66.4	− 0.3	89	20	76	46	26	57	29	59	55	72	2.15	− 0.9	6	6,100	ne.	32	sw.	1	14	10	6	4.1	.....	.....
Terre Haute	575	96	129	29.51	30.12	.....	67.1	.....	90	19	77	44	26	57	31	60	56	73	2.77	.....	8	5,725	s.	30	nw.	6	13	9	8	5.0	.....	.....
Cincinnati	628	152	160	29.48	30.15	+ .08	68.4	− 0.6	92	21	78	46	27	59	28	60	56	71	0.90	− 1.4	4	3,920	e.	21	sw.	1	15	11	4	4.0	.....	.....
Columbus	824	173	222	29.29	30.16	+ .09	64.8	− 1.1	92	21	75	43	26	54	30	56	51	67	1.26	− 1.3	7	6,970	se.	28	nw.	2	19	6	5	3.1	.....	.....
Dayton	899	181	216	29.18	30.13	.....	65.7	− 1.7	92	20	76	44	26	55	30	57	54	72	0.71	− 1.8	6	6,285	ne.	28	sw.	1	16	11	3	3.3	.....	.....
Pittsburgh	842	353	410	29.26	30.17	+ .09	63.6	− 2.5	90	22	74	40	28	54	32	55	50	67	0.69	− 1.8	5	6,845	nw.	53	nw.	2	14	8	8	4.3	.....	.....
Elkins	1,940	41	50	28.14	30.19	+ .11	60.5	− 1.4	89	2	74	29	29	47	45	53	50	82	0.52	− 2.4	5	2,110	n.	14	w.	4	15	7	8	4.2	.....	.....
Parkersburg	638	77	84	29.52	30.18	+ .10	65.5	− 0.6	92	2	77	39	27	54	37	56	52	72	0.62	− 2.1	4	3,122	se.	25	nw.	2	14	12	4	3.9	.....	.....
Lower Lake Region.							**61.7**	**− 1.5**										**71**	**1.72**	**− 1.1**										**4.2**		
Buffalo	767	247	280	29.32	30.15	+ .09	61.6	− 1.3	83	18	69	45	26	54	25	56	52	76	2.31	− 0.9	9	10,019	sw.	60	sw.	3	13	10	7	4.5	.....	.....
Canton	448	10	61	29.65	30.13	.....	57.4	− 1.9	87	22	68	28	29	46	37	.....	.....	.....	1.73	− 1.1	11	5,726	sw.	31	w.	7	14	6	10	4.1	.....	.....
Oswego	335	76	91	29.76	30.13	+ .07	59.9	− 2.8	89	22	68	40	29	52	27	54	50	72	1.32	− 1.5	11	6,160	s.	26	nw.	7	12	7	11	4.7	.....	.....
Rochester	523	97	113	29.59	30.16	+ .10	61.1	− 0.8	90	22	70	38	28	52	30	54	50	70	1.01	− 1.3	7	5,037	sw.	25	sw.	3	15	5	10	4.4	.....	.....
Syracuse	597	97	113	29.51	30.16	+ .09	60.2	− 1.4	88	22	69	38	29	52	28	54	50	74	1.47	− 1.4	8	6,493	s.	36	nw	7	15	4	11	4.6	.....	.....
Erie	714	92	102	29.38	30.15	+ .09	62.3	− 1.6	87	22	70	40	28	55	28	55	49	64	1.50	− 2.0	9	6,509	s.	28	sw.	1	12	12	6	4.4	.....	.....
Cleveland	762	190	201	29.34	30.16	+ .10	62.6	− 1.7	88	22	70	41	28	55	28	55	50	68	1.16	− 2.1	8	7,882	se.	36	w.	22	15	7	8	4.4	.....	.....
Sandusky	629	62	103	29.48	30.16	+ .10	63.7	− 1.6	90	22	71	45	28	56	27	56	52	70	1.74	− 0.9	9	7,865	ne.	32	w.	22	12	13	5	4.3	.....	.....
Toledo	628	208	246	29.48	30.17	+ .11	63.2	− 0.9	89	21	72	44	9	54	28	56	52	72	2.05	− 0.3	9	9,102	sw.	42	sw.	22	18	9	3	3.0	.....	.....
Fort Wayne	856	113	124	29.23	30.16	.....	63.6	− 1.9	90	20	74	42	26	53	31	57	53	75	2.51	.....	7	5,839	ne.	34	sw.	6	16	7	7	3.8	.....	.....
Detroit	730	218	245	29.37	30.16	+ .10	62.8	− 0.3	88	21	71	46	28	54	30	55	51	72	2.87	+ 0.4	9	8,131	w.	40	w.	3	14	9	7	4.3	.....	.....
Upper Lake Region.							**59.9**	**+ 0.8**										**79**	**2.28**	**− 0.9**										**4.7**		
Alpena	609	13	92	29.47	30.14	+ .11	57.5	+ 0.2	89	21	67	34	28	48	32	53	50	80	0.65	− 2.8	9	7,667	se.	35	se.	14	6	17	7	5.6	.....	.....
Escanaba	612	54	60	29.44	30.10	+ .09	57.2	+ 0.3	77	29	64	36	9	50	29	53	51	83	2.07	− 1.5	12	6,417	s.	29	s.	14	11	6	13	5.4	.....	.....
Grand Haven	632	54	92	29.44	30.12	+ .08	60.8	− 0.3	84	18	70	39	26	52	32	55	52	78	2.06	− 1.1	8	7,248	s.	40	w.	3	19	8	3	2.9	.....	.....
Grand Rapids	707	70	87	29.37	30.14	+ .09	62.6	+ 0.8	89	20	72	41	26	53	33	56	52	74	2.34	− 0.8	8	3,932	e.	31	w.	3	12	11	7	4.2	.....	.....
Houghton	684	62	72	29.33	30.06	+ .06	58.1	+ 2.0	88	20	67	38	8	49	32	.....	.....	.....	1.82	− 1.7	11	5,860	w.	34	w.	22	10	7	13	5.5	.....	.....
Lansing	878	11	62	29.20	30.15	.....	60.3	− 1.0	89	20	72	37	26	48	37	54	51	82	2.65	0.0	8	3,637	se.	19	s.	5	14	10	6	3.9	.....	.....
Ludington	637	60	66	29.42	30.12	.....	59.7	.....	79	21	68	39	9	52	25	56	53	81	3.15	.....	10	7,137	s.	35	w.	3	15	10	5	4.2	.....	.....
Marquette	734	77	111	29.30	30.11	+ .11	58.2	+ 1.4	90	20	67	40	9	50	31	53	50	79	1.28	− 2.2	16	7,888	s.	38	se.	14	7	11	12	6.1	.....	.....
Port Huron	638	70	120	29.45	30.14	+ .08	60.6	− 0.3	88	21	70	39	26	52	27	55	52	77	2.47	− 0.2	8	7,311	sw.	45	nw.	22	12	16	2	3.9	.....	.....
Saginaw	641	48	82	29.45	30.15	.....	60.6	.....	87	20	71	39	26	50	33	55	53	80	1.51	− 1.6	10	6,002	s.	30	sw.	3	15	8	7	4.4	.....	.....
Sault Ste. Marie	614	11	61	29.43	30.13	+ .11	56.4	+ 2.1	85	20	65	36	28	48	35	52	50	83	2.05	− 1.4	13	5,610	se.	31	nw.	26	8	4	18	6.7	.....	.....
Chicago	823	140	310	29.25	30.13	+ .09	66.6	+ 2.0	88	20	73	50	23	60	23	59	54	68	1.56	− 1.5	9	8,082	ne.	44	sw.	6	19	5	6	3.3	.....	.....
Green Bay	617	109	144	29.44	30.10	+ .08	61.1	+ 2.0	86	20	69	42	23	53	26	55	52	80	4.86	+ 1.7	7	7,329	s.	36	w.	3	9	13	8	6.0	.....	.....
Milwaukee	681	119	133	29.38	30.12	+ .09	63.2	+ 1.7	86	21	70	46	25	56	23	56	53	74	4.11	+ 1.2	10	6,982	se.	32	se.	13	16	9	5	3.9	.....	.....
Duluth	1,133	11	47	28.84	30.06	+ .08	56.0	− 0.7	83	20	64	36	25	48	27	52	50	86	2.55	− 1.0	13	8,536	ne.	40	sw.	21	13	7	10	5.0	.....	.....
North Dakota.							**59.6**	**+ 2.4**										**70**	**1.16**	**− 0.3**										**3.9**		
Moorhead	940	8	57	28.98	29.99	+ .03	60.6	+ 4.0	88	20	73	33	25	48	38	53	49	77	1.50	− 0.8	8	6,503	se.	40	se.	12	21	4	5	2.7	.....	.....
Bismarck	1,674	8	57	28.20	29.97	+ .03	61.0	+ 3.9	95	18	75	33	29	47	48	51	46	70	1.10	− 0.1	7	7,736	nw.	40	s.	12	19	7	4	3.4	.....	.....
Devils Lake	1,482	11	44	28.37	29.94	.00	58.4	+ 2.8	89	18	71	33	22	46	37	50	45	70	1.57	+ 0.2	10	8,088	se.	37	s.	12	10	14	6	4.7	.....	.....
Williston	1,872	40	47	27.94	29.90	− .03	58.6	− 0.9	91	18	72	35	3	45	44	49	43	63	0.46	− 0.4	6	4,685	se.	33	se.	8	10	15	5	4.7	.....	.....
Upper Mississippi Valley.							**65.7**	**+ 0.9**										**78**	**5.25**	**+ 1.9**										**4.5**		
Minneapolis	918	10	208	29.05	30.03	.....	62.4	.....	85	20	72	42	25	53	29	.....	.....	.....	2.76	− 0.9	5	8,562	se.	37	se.	13	13	9	8	4.9	.....	.....
St. Paul	837	201	236	29.15	30.06	+ .07	61.8	+ 1.5	84	20	71	43	25	53	29	.....	.....	.....	2.16	− 1.3	8	8,995	s.	40	s.	13	11	9	10	5.1	.....	.....
La Crosse	714	11	48	29.34	30.08	+ .07	62.4	+ 0.7	85	20	73	40	25	52	29	.....	.....	.....	4.14	0.0	9	3,325	s.	22	sw.	21	10	9	11	5.5	.....	.....
Madison	974	70	78	29.08	30.12	+ .09	62.5	+ 1.4	85	20	72	43	23	54	27	56	53	78	3.49	+ 0.3	7	6,164	s.	25	s.	14	13	9	8	4.7	.....	.....
Charles City	1,015	10	49	29.01	30.08	+ .08	62.0	+ 0.3	84	19	73	38	25	51	31	56	54	84	6.64	+ 3.8	10	4,695	se.	28	w.	21	17	6	7	4.3	.....	.....
Davenport	606	71	79	29.44	30.10	+ .07	66.4	+ 1.7	87	19	76	45	25	56	28	59	56	76	6.27	+ 3.1	11	4,875	e.	37	w.	5	15	6	9	4.3	.....	.....
Des Moines	861	84	97	29.15	30.05	+ .03	65.8	+ 0.8	93	5	76	47	26	56	30	59	56	78	14.81	+11.7	9	5,325	se.	31	sw.	13	12	10	8	4.7	.....	.....
Dubuque	698	81	96	29.37	30.11	+ .08	64.4	+ 0.8	85	20	74	43	26	55	26	57	54	75	4.75	+ 1.2	10	4,208	s.	20	nw.	22	15	7	8	4.3	.....	.....
Keokuk	614	64	78	29.43	30.09	+ .06	67.4	+ 1.0	86	19	77	44	23	58	27	60	58	78	6.22	+ 2.2	9	5,010	s.	25	s.	5	14	11	5	3.9	.....	.....
Cairo	356	87	93	29.72	30.10	+ .05	70.7	+ 0.5	91	6	79	50	27	62	25	64	62	80	3.73	+ 1.3	8	5,238	ne.	37	w.	6	13	8	9	4.6	.....	.....
Peoria	609	11	45	29.46	30.13	+ .09	66.2	+ 1.9	88	19	77	43	26	55	34	58	56	82	5.55	+ 2.4	11	4,021	s.	28	w.	14	16	6	8	4.1	.....	.....
Springfield, Ill	644	10	91	29.42	30.10	+ .05	67.7	+ 1.3	90	1	78	46	26	58	29	59	56	72	1.82	− 1.6	8	5,580	s.	30	nw.	1	16	5	9	4.4	.....	.....
Hannibal	534	74	109	29.53	30.10	+ .07	68.0	+ 0.1	91	1	78	44	23	58	32	.....	.....	.....	4.48	+ 0.9	10	5,765	s.	38	sw.	14	14	8	8	4.1	.....	.....
St. Louis	567	265	303	29.49	30.09	+ .05	69.6	− 0.4	89	6	78	52	25	62	22	63	60	76	6.68	+ 3.8	9	8,359	s.	38	se.	14	14	10	6	4.2	.....	.....
Missouri Valley.							**67.4**	**+ 2.1**										**71**	**5.23**	**+ 2.4**										**4.2**		
Columbia, Mo	781	11	84	29.25	30.08	+ .05	69.0	+ 1.2	94	1	79	44	23	59	31	.....	.....	.....	2.56	− 0.3	11	4,939	se.	32	nw.	1	12	6	12	5.1	.....	.....
Kansas City	963	161	181	29.02	30.05	+ .03	70.4	+ 2.9	94	5	79	50	23	62	24	63	60	76	16.17	+12.4	12	8,184	s.	35	sw.	6	12	10	8	4.6	.....	.....
St. Joseph	967	11	49	29.02	30.04	.....	69.9	.....	95	5	80	47	23	60	29	62	59	77	6.21	.....	11	5,576	se.	34	nw.	21	13	9	8	4.3	.....	.....
Springfield, Mo	1,324	98	104	28.69	30.08	+ .05	70.6	+ 2.7	89	1	79	47	23	62	27	63	60	76	3.59	− 0.2	8	7,156	se.	33	nw.	10	13	15	2	3.6	.....	.....
Iola	984	11	50	29.01	30.03	+ .02	71.8	+ 3.2	95	5	83	45	23	60	34	.....	.....	.....	5.19	+ 1.8	9	4,937	s.	24	se.	8	16	10	4	3.2	.....	.....
Topeka	983	85	101	.....	.....	.....	70.9	+ 2.6	96	5	81	47	23	60	31	.....	.....	.....	6.61	+ 3.0	12	7,142	s.	36	s.	14	13	11	6	4.0	.....	.....
Lincoln	1,189	11	84	28.76	30.01	+ .02	68.2	+ 3.0	101	5	80	45	25	57	34	60	56	74	8.32	+ 5.7	11	7,005	se.	48	nw.	7	14	8	8	4.3	.....	.....
Omaha	1,105	115	121	28.86	30.03	+ .03	68.2	+ 2.4	100	5	78	46	22	58	28	60	56	73	3.56	+ 0.5	10	5,433	se.	26	nw.	21	15	8	7	4.5	.....	.....
Valentine	2,598	47	54	27.30	30.00	+ .04	62.8	+ 0.5	93	27	76	36	22	50	42	53	47	65	2.65	+ 0.9	7	8,268	s.	38	s.	26	15	6	9	4.4	.....	.....
Sioux City	1,135	94	164	28.82	30.03	+ .04	64.1	0.0	88	5	75	43	22	53	33	57	53	73	7.05	+ 4.6	7	9,414	s.	43	nw.	13	13	10	7	4.5	.....	.....
Huron	1,306	59	74	28.63	30.03	+ .07	62.6	+ 3.0	87	18	75	39	22	50	36	54	50	71	3.43	+ 1.7	6	8,830	se.	46	s.	15	15	9	6	4.3	.....	.....
Pierre	1,572	70	75	28.34	29.99	+ .04	66.0	+ 3.2	97	18	78	40	22	54	37	54	46	58	0.79	− 0.3	6	7,572	se.	40	s.	15	15	8	7	3.8	.....	.....
Yankton	1,233	49	57	28.70	30.01	+ .03	64.3	+ 1.0	89	5	76	41	4	53	37	.....	.....	.....	2.84	+ 0.4	7	6,297	w.	31	s.	15	14	9	7	4.4	.....	.....

TABLE I.—*Climatological data for United States Weather Bureau stations, September, 1914*—Continued.

Districts and stations.	Elevation of instruments.			Pressure, in inches.			Temperature of the air, in degrees Fahrenheit.									Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity, per cent.	Precipitation, in inches.			Wind.					Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Barometer above sea level, feet.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.				Total.	Departure from normal.	Days with 0.01 or more.	Total movement, miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.						
Northern Slope.							**58.0**	**+ 0.7**										**58**	**1.03**	**− 0.1**										**4.3**		
Havre	2,505	11	44	27.27	29.88	+ .06	56.8	− 0.8	88	3	71	34	29	43	46	49	43	69	1.37	+ 0.3	7	5,465	sw.	50	w.	18	13	11	6	4.1	.....	....
Helena	4,110	87	114	25.77	29.93	− .04	56.4	+ 0.2	87	3	69	35	12	44	42	45	36	52	1.46	+ 0.4	6	6,257	sw.	41	sw.	18	13	6	11	5.1	T.	....
Kalispell	2,962	11	34	26.90	29.94	− .02	52.6	− 1.3	82	3	65	34	29	40	39	45	40	70	1.21	− 0.1	12	2,481	w.	24	sw.	18	11	9	10	5.0	.....	....
Miles City	2,371	26	48	27.42	29.95	.00	62.2	+ 1.0	97	18	78	38	2	47	49	52	47	67	1.16	+ 0.2	8	3,479	s.	27	se.	9	15	12	3	3.5	.....	....
Rapid City	3,259	50	58	26.60	29.97	+ .01	63.4	+ 4.3	98	19	77	37	14	50	46	50	40	50	1.22	0.0	7	6,008	w.	33	s.	20	12	15	3	4.0	.....	....
Cheyenne	6,088	84	101	24.08	29.96	.00	58.0	+ 0.8	84	19	73	28	14	43	39	44	34	47	0.41	− 0.5	2	7,725	w.	60	w.	12	9	18	3	4.6	1.0	....
Lander	5,372	60	68	24.67	29.95	− .01	57.4	+ 2.2	86	18	75	25	13	40	45	44	31	43	T.	− 1.0	0	3,914	sw.	64	sw.	15	13	15	2	4.1	.....	....
Sheridan	3,790	10	47	26.09	29.96	......	57.2	......	94	18	76	30	2	38	54	46	38	61	0.80	......	7	3,472	s.	30	nw.	20	12	11	7	4.4	.....	....
Yellowstone Park	6,200	11	48	23.92	29.99	+ .02	49.8	− 3.6	79	3	64	28	12	36	45	40	33	61	2.24	+ 1.2	9	5,593	s.	39	s.	11	12	10	8	4.9	T.	....
North Platte	2,821	11	51	27.12	30.02	+ .05	65.5	+ 2.3	90	18	80	36	22	51	40	55	49	65	0.17	− 1.3	5	5,406	se.	28	se.	12	17	9	4	3.4	.....	....
Middle Slope.							**71.0**	**+ 3.4**										**62**	**1.79**	**− 0.2**										**3.3**		
Denver	5,291	129	172	24.78	29.96	.00	64.8	+ 2.1	91	18	80	35	14	49	48	50	39	46	0.21	− 0.7	4	5,262	sw.	36	sw.	12	15	13	2	3.6	.....	....
Pueblo	4,685	80	86	25.33	29.95	− .01	66.8	+ 2.4	93	5	84	36	24	50	49	51	42	50	0.32	− 0.3	3	3,959	nw.	44	nw.	9	19	11	0	2.7	.....	....
Concordia	1,398	42	50	28.55	30.00	+ .01	72.4	+ 4.3	103	5	85	47	25	60	40	62	57	69	4.61	+ 2.0	8	5,508	s.	26	s.	13	10	14	6	4.4	.....	....
Dodge	2,509	11	51	27.44	29.99	+ .01	72.6	+ 4.4	100	5	86	43	24	59	37	60	54	64	0.53	− 1.2	5	7,675	s.	35	se.	13	19	11	0	2.9	.....	....
Wichita	1,358	139	158	28.57	29.98	− .02	73.6	+ 3.8	97	5	84	49	23	63	28	64	59	68	3.39	+ 0.3	8	9,816	s.	48	sw.	13	21	6	3	2.8	.....	....
Oklahoma	1,214	10	47	28.76	30.02	+ .03	75.5	+ 3.4	93	10	86	48	23	66	26	65	62	72	1.70	− 1.0	2	9,895	s.	39	n.	22	17	8	5	3.5	.....	....
Southern Slope.							**74.7**	**+ 1.9**										**62**	**0.66**	**− 1.9**										**2.6**		
Abilene	1,738	10	52	28.23	30.01	+ .05	75.1	+ 0.9	92	13	86	47	30	64	36	65	61	70	0.91	− 2.2	4	6,285	s.	31	s.	13	19	6	5	2.7	.....	....
Amarillo	3,676	10	49	26.32	29.98	......	72.8	+ 5.1	98	6	87	49	28	59	33	59	53	63	1.07	− 1.3	5	7,938	sw.	40	sw.	15	21	9	0	3.1	.....	....
Del Rio	944	64	71	29.00	29.97	+ .03	79.6	+ 0.7	96	13	90	54	24	69	32	....	....	....	0.59	− 1.9	3	6,460	se.	31	n.	22	20	9	1	2.4	.....	....
Roswell	3,566	75	85	26.42	29.96	+ .04	71.2	+ 0.9	95	6	86	43	29	57	36	57	49	53	0.05	− 2.2	2	5,349	s.	33	nw.	10	22	7	1	2.3	.....	....
Southern Plateau.							**72.1**	**+ 1.5**										**46**	**0.27**	**− 0.6**										**2.7**		
El Paso	3,762	110	133	26.23	29.91	+ .03	74.3	+ 1.6	94	8	86	53	25	62	30	59	50	50	0.56	− 0.9	7	6,759	e.	36	se.	2	15	14	1	3.2	.....	....
Santa Fe	7,013	57	62	23.37	29.94	+ .01	63.0	+ 2.4	82	18	74	44	23	52	27	49	39	49	0.59	− 1.0	8	4,460	se.	34	sw.	13	16	11	3	3.8	.....	....
Flagstaff	6,908	8	57	......	......	......	58.0	+ 2.5	82	18	73	32	23	43	42	....	....	....	0.56	......	4	......	nw.	48	sw.	13	15	12	3	....	.....	....
Phoenix	1,108	76	81	28.69	29.81	.00	84.5	+ 3.1	104	18	98	64	14	71	38	65	53	38	T.	− 1.0	0	3,698	e.	19	e.	24	19	9	2	3.1	.....	....
Yuma	141	9	58	29.65	29.79	+ .01	85.8	+ 1.9	108	4	101	62	14	70	41	69	61	51	T.	− 0.2	0	3,687	w.	23	s.	11	27	2	1	0.9	.....	....
Independence	3,910	11	42	25.94	29.87	+ .01	66.8	− 2.3	88	4	83	39	14	51	40	53	41	44	0.21	+ 0.1	2	4,574	se.	24	nw.	12	24	4	2	2.5	.....	....
Middle Plateau.							**61.8**	**+ 0.2**										**39**	**0.31**	**− 0.5**										**3.1**		
Reno	4,532	74	81	25.46	29.91	− .04	60.5	+ 0.8	87	23	77	33	13	44	46	46	34	45	0.05	− 0.2	1	4,975	w.	37	sw.	15	18	10	2	2.8	.....	....
Tonopah	6,090	12	20	24.10	29.92	......	61.8	......	80	19	73	35	13	51	29	46	29	33	0.27	− 0.2	2	6,845	se.	33	se.	25	16	12	2	3.0	.....	....
Winnemucca	4,344	18	56	25.61	29.96	− 0.3	57.8	− 2.7	89	1	77	22	13	39	49	44	31	42	0.48	+ 0.1	3	4,352	ne.	36	s.	25	17	8	5	3.0	.....	....
Modena	5,479	10	43	24.65	29.92	.00	60.6	+ 0.4	84	19	77	31	22	44	46	45	27	35	0.49	− 0.6	3	8,707	sw.	52	s.	15	20	7	3	2.4	0.4	....
Salt Lake City	4,360	147	189	25.62	29.93	− 0.2	64.4	− 0.7	89	19	76	35	12	52	38	50	37	41	0.17	− 0.7	5	6,110	se.	44	nw.	15	13	12	5	4.0	T.	....
Durango	6,546	10	....	......	......	......	60.0	+ 1.8	85	19	77	30	14	43	43	....	....	....	0.39	− 1.5	3	......	nw.	....	......	....	18	6	6	3.7	.....	....
Grand Junction	4,602	82	96	25.40	29.94	− 0.1	67.8	+ 1.4	90	6	81	37	14	55	38	51	38	40	0.30	− 0.6	4	5,862	se.	35	w.	12	18	9	3	3.1	.....	....
Northern Plateau.							**59.1**	**− 2.1**										**50**	**1.15**	**− 0.2**										**4.6**		
Baker	3,471	48	53	26.44	30.01	+ .02	54.4	− 2.6	86	2	69	29	13	40	44	44	32	50	0.76	0.0	8	4,538	se.	42	s.	18	14	12	4	4.0	T.	....
Boise	2,739	78	86	27.14	29.98	+ .01	61.4	− 0.5	93	2	75	34	13	48	43	47	34	41	0.35	− 0.1	4	4,129	nw.	32	nw.	11	15	5	10	4.0	.....	....
Lewiston	757	40	48	29.14	29.94	− .04	61.9	− 1.6	93	2	76	41	28	48	47	....	....	....	0.70	0.0	9	2,111	e.	34	w.	26	13	6	11	4.6	.....	....
Pocatello	4,477	46	54	25.49	29.98	+ .02	57.6	− 3.1	88	3	72	30	13	44	43	45	34	50	2.64	− 1.8	8	5,221	se.	44	sw.	12	10	12	8	4.7	1.0	....
Spokane	1,929	101	110	27.91	29.95	− .03	57.6	− 1.2	86	2	69	41	12	46	43	48	39	57	0.91	− 0.1	9	4,496	s.	37	sw.	18	10	5	15	5.5	.....	....
Walla Walla	1,000	57	65	28.88	29.95	− .05	61.6	− 3.8	91	2	72	43	16	51	35	51	42	53	1.52	+ 0.6	9	3,373	s.	24	w.	18	14	5	11	5.0	.....	....
North Pacific Coast Region.							**55.9**	**− 1.0**										**81**	**3.09**	**+ 0.7**										**7.0**		
North Head	211	11	56	29.78	30.00	− .03	54.6	− 1.6	68	23	57	48	11	52	15	53	52	90	2.59	+ 0.7	16	11,106	se.	92	se.	18	4	7	19	7.4	.....	....
Port Crescent	259	8	53	29.71	29.99	− .03	51.1	− 1.4	69	22	58	35	12	44	28	....	....	....	3.49	+ 1.2	15	2,967	s.	24	s.	18	2	9	19	7.8	.....	....
Seattle	125	215	250	29.86	29.99	− .02	56.7	− 1.2	73	23	63	46	12	51	22	53	50	81	1.42	− 0.5	13	6,110	s.	42	s.	18	3	6	21	7.8	.....	....
Tacoma	213	113	120	29.77	30.00	− .02	56.4	− 1.2	77	24	64	44	17	49	28	52	49	77	2.25	− 0.2	14	4,022	sw.	31	sw.	14	4	9	17	6.8	.....	....
Tatoosh Island	109	7	57	29.86	29.96	− .05	53.0	0.0	61	23	56	46	1	50	9	52	51	94	5.99	− 0.2	20	8,553	s.	52	s.	27	3	7	20	7.8	.....	....
Portland, Oreg	153	68	106	29.83	29.99	− .04	59.4	− 1.2	84	23	67	45	6	51	29	54	50	74	3.10	+ 1.3	12	3,958	nw.	27	w.	11	5	6	19	7.1	.....	....
Roseburg	510	9	57	29.47	30.02	.00	60.1	− 0.4	87	23	71	41	28	49	38	53	48	69	2.80	+ 1.8	11	2,307	s.	22	sw.	16	10	18	2	4.4	.....	....
Middle Pacific Coast Region.							**61.9**	**− 1.5**										**61**	**0.32**	**− 0.3**										**3.2**		
Eureka	62	73	89	29.98	30.05	+ .04	55.0	+ 0.1	76	17	60	44	27	50	16	53	51	87	1.82	+ 0.7	10	5,020	n.	44	sw.	18	9	11	10	5.5	.....	....
Mount Tamalpais	2,375	11	18	27.53	29.99	+ .05	60.8	− 5.3	87	10	68	45	2	54	21	51	42	56	0.13	− 0.5	3	10,546	nw.	56	nw.	15	22	7	1	2.2	.....	....
Point Reyes Light	490	7	18	29.44	29.96	......	55.2	− 0.9	79	10	60	49	13	51	27	....	....	....	0.15	......	1	14,264	nw.	68	nw.	11	9	10	11	5.3	.....	....
Red Bluff	332	50	56	29.56	29.91	− .02	71.1	− 2.8	96	10	84	49	8	58	36	55	41	39	T.	− 0.8	0	4,748	nw.	32	n.	12	20	7	3	2.2	.....	....
Sacramento	69	106	117	29.85	29.92	+ .03	67.5	− 1.6	95	10	81	47	4	54	38	56	45	53	T.	− 0.4	0	6,061	s.	25	nw.	12	27	2	1	1.2	.....	....
San Francisco	155	200	204	29.80	29.97	+ .03	60.8	+ 1.5	92	10	68	51	6	54	35	54	51	78	T.	− 0.3	0	5,728	w.	28	w.	4	12	14	4	3.9	.....	....
San Jose	141	12	110	29.83	29.98	......	63.2	− 1.5	95	10	77	42	8	50	46	....	....	....	0.00	− 0.3	0	4,037	nw.	22	nw.	7	26	4	0	1.8	.....	....
South Pacific Coast Region.							**67.1**	**− 0.2**										**67**	**0.06**	**− 0.2**										**2.9**		
Fresno	327	89	98	29.56	29.91	+ .04	71.6	− 2.7	99	11	87	52	7	56	40	57	44	44	0.22	0.0	2	5,619	nw.	30	nw.	7	25	3	2	1.6	.....	....
Los Angeles	338	159	191	29.57	29.94	+ .06	67.9	+ 1.4	88	26	77	51	16	58	28	59	56	72	0.00	− 0.1	0	3,418	sw.	18	s.	18	16	12	2	3.4	.....	....
San Diego	87	62	70	29.80	29.92	+ .03	66.0	− 0.9	78	26	71	54	15	61	16	61	58	81	T.	− 0.1	0	4,639	nw.	24	nw.	3	20	8	2	3.4	.....	....
San Luis Obispo	201	32	40	29.77	29.99	+ .06	62.8	+ 1.3	89	9	75	43	7	51	34	54	54	72	T.	− 0.4	0	2,472	nw.	16	w.	7	17	11	2	3.1	.....	....
West Indies.																																
San Juan	**82**	**8**	**54**	**29.89**	**29.97**	**+ .03**	**80.8**	......	**91**	**10**	**86**	**73**	**18**	**75**	**16**	......	....	....	**3.20**	**− 3.6**	**16**	**8,294**	**se.**	**32**	**ne.**	**13**	**9**	**21**	**0**	**4.0**		
Panama.																																
Ancon	92	6	69	29.72	29.82	......	80.3	......	94	14	88	70	27	73	21	75	75	90	9.60	+ 1.8	17	4,393	nw.	22	ne.	26	0	3	27	9.0		
Culebra[1]	404	5	62	......	......	......	......	......	....	....	....	....	....	....	....	....	....	....	11.12	− 0.1	25											
Colon	10	5	71	29.82	29.83	......	79.4	......	88	21	83	72	26	76	10	77	76	89	14.80	+ 2.3	27	6,274	w.	27	w.	1	1	7	22	8.1		

[1] Meteorological station discontinued Sept. 12, 1914.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during September, 1914, at all stations furnished with self-registering gages.*

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive rate began.	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Abilene, Tex.	18	6.52 p.m.	8.30 p.m.	0.52	7.24 p.m.	7.37 p.m.	.08	.20	.35	.40											
Albany, N. Y.	2			0.19														.11			
Alpena, Mich.	6			0.43														.40			
Amarillo, Tex.	11			0.42														.16			
Anniston, Ala.	24			1.91														.74			
Asheville, N. C.	20	3.45 p.m.	4.35 p.m.	0.52	3.51 p.m.	4.17 p.m.	.0'	.15	.31	.37	.43	.48	.50								
Atlanta, Ga.	2	1.10 p.m.	2.40 p.m.	0.54	1.45 p.m.	1.56 p.m.	.03	.19	.39	.44											
Atlantic City, N. J.	3			0.10														.10			
Augusta, Ga.	25			1.44														.38			
Baker, Oreg.	19			0.10														.09			
Baltimore, Md.	11–12	3.40 p.m.	D.N. a.m.	1.23	6.58 p.m.	7.16 p.m.	.19	.10	.29	.43	.54										
Bentonville, Ark.	2			0.70														.58			
Binghamton, N.Y.	2	5.08 p.m.	6.30 p.m.	0.54	5.11 p.m.	5.25 p.m.	.01	.08	.22	.36											
Birmingham, Ala.	12			0.89														.50			
Bismarck, N. Dak.	7			0.47														.21			
Block Island, R. I.	4			0.16														.16			
Boise, Idaho	11			0.14														.11			
Boston, Mass.	4			0.13														.13			
Buffalo, N. Y.	1	3.25 p.m.	5.50 p.m.	0.80	4.55 p.m.	5.17 p.m.	.13	.11	.23	.42	.61	.66									
Burlington, Vt.	6	D.N. p.m.	D.N. p.m.	0.60	11.27 p.m.	11.37 p.m.	.13	.28	.43												
Cairo, Ill.	6	5.20 p.m.	10.05 p.m.	1.67	5.22 p.m.	5.57 p.m.	0.01	.13	.34	.49	.61	.72	1.07	1.31							
Canton, N. Y.	7			0.21														.21			
Charles City, Iowa	21	6.11 p.m.	10.30 p.m.	1.23	6.14 p.m.	6.45 p.m.	.02	.18	.29	.42	.46	.53	.67	.70							
Charleston, S. C.	16–17	8.25 p.m.	D.N. a.m.	1.60	1.29 a.m.	1.58 a.m.	.70	.20	.33	.47	.53	.71	.88								
Charlotte, N. C.	24			0.62														.18			
Chattanooga, Tenn.	11			0.45														.22			
Cheyenne, Wyo.	13			0.39														(*)			
Chicago, Ill.	1	D.N. a.m.	D.N. a.m.	0.44	2.44 a.m.	2.59 a.m.	.01	.14	.27	.38	.40										
Cincinnati, Ohio	23			0.72														.19			
Cleveland, Ohio	2			0.39														.29			
Columbia, Mo.	8			0.54														.33			
Columbia, S. C.	8			0.82														.61			
Columbus, Ohio	2			0.19														.19			
Concord, N. H.	30			0.15														.10			
Concordia, Kans.	9–10	8.51 p.m.	2.00 a.m.	3.05	9.10 p.m.	9.37 p.m.	.10	.10	.30	.46	.59	.65	.72								
					10.19 p.m.	10.48 p.m.	.90	.12	.40	.61	.86	1.10	1.23								
Corpus Christi, Tex.	23	12.03 a.m.	5.20 a.m.	2.43	12.27 a.m.	1.42 a.m.	.14	.10	.21	.26	.34	.51	.73	.88	1.02	1.11	1.23	1.46	1.77		
Davenport, Iowa	5–6	6.40 p.m.	2.00 a.m.	3.19	6.57 p.m.	7.50 p.m.	0.01	.10	.34	.50	.57	.61	.70	.82	.87	.97	1.01	1.09			
					9.38 p.m.	11.13 p.m.	1.19	.10	.29	.40	.58	.72	.82	.87	1.09	1.25	1.31	1.33	1.49	1.86	
Dayton, Ohio	22			0.11														.11			
Del Rio, Tex.	18–19																	(*)			
Denver, Colo.	29			0.14														.12			
Des Moines, Iowa	9–10	10.10 p.m.	10.15 a.m.	1.97	12.11 a.m.	12.54 a.m.	.21	.06	.12	.22	.32	.43	.63	.92	1.21	1.29					
Do.	13	D.N. a.m.	4.45 a.m.	1.24	2.32 a.m.	2.53 a.m.	.18	.17	.38	.58	.69	.72									
		5.42 p.m.	D.N. p.m.	2.33	7.31 p.m.	8.18 p.m.	.54	.16	.29	.49	.59	.63	.63	.65	.80	.94	.99				
					8.51 p.m.	9.23 p.m.	1.61	.10	.23	.30	.37	.51	.59	.64							
Do.	16	4.20 p.m.	7.30 p.m.	3.35	5.16 p.m.	7.01 p.m.	.03	.09	.15	.26	.49	.69	.96	1.21	1.56	1.68	1.80	1.98	2.37	3.24	3.32
		7.50 p.m.	D.N. p.m.	1.52	9.54 p.m.	10.21 p.m.	.33	.18	.58	.81	.95	1.02	1.08								
Do.	21	5.27 p.m.	D.N. p.m.	1.59	6.01 p.m.	6.39 p.m.	.02	.05	.09	.21	.30	.41	.51	.61	.69						
Detroit, Mich.	1			0.85														.57			
Devils Lake, N. Dak.	15	9.02 p.m.	D.N. p.m.	0.63	9.02 p.m.	9.38 p.m.	.00	.09	.19	.37	.39	.39	.42	.55	.58						
Dodge City, Kans.	9			0.28														.25			
Dubuque, Iowa	14	7.55 a.m.	1.08 p.m.	1.69	11.32 a.m.	12.17 p.m.	.84	.06	.17	.28	.39	.46	.55	.63	.73	.80					
		6.51 p.m.	8.55 p.m.	1.02	6.54 p.m.	7.24 p.m.	.01	.06	.09	.15	.45	.67	.73								
Duluth, Minn.	16			0.36														.36			
Eastport, Me.	2	2.55 a.m.	3.45 a.m.	0.77	3.13 a.m.	3.32 a.m.	.10	.22	.40	.51	.67										
Do.	3	6.00 a.m.	7.30 a.m.	0.72	6.48 a.m.	7.15 a.m.	.03	.18	.26	.30	.47	.60	.63								
Elkins, W. Va.	11			0.31														.09			
El Paso, Tex.	2			0.17														.13			
Erie, Pa.	1	4.07 p.m.	5.44 p.m.	0.39	5.14 p.m.	5.29 p.m.	.01	.12	.19	.36											
Escanaba, Mich.	14			0.90														.33			
Eureka, Cal.	18			0.75														.49			
Evansville, Ind.	7	5.03 p.m.	7.35 p.m.	1.49	5.07 p.m.	6.11 p.m.	.01	.16	.50	.65	.73	.86	.91	.94	.94	.95	1.00	1.27	1.38		
Do.	8	D.N. a.m.	6.20 a.m.	1.46	4.26 a.m.	5.20 a.m.	.52	.14	.19	.21	.27	.31	.40	.47	.61	.67	.75	.85			
Fort Smith, Ark.	12	7.49 a.m.	10.48 a.m.	1.42	9.08 a.m.	9.58 a.m.	.09	.11	.19	.29	.46	.63	.86	.98	1.10	1.23	1.29				
Fort Wayne, Ind.	22	2.45 p.m.	5.20 p.m.	0.53	3.13 p.m.	3.23 p.m.	.01	.26	.40												
Fort Worth, Tex.	22	12.22 p.m.	3.45 p.m.	1.39	12.34 p.m.	1.04 p.m.	.02	.18	.34	.61	.86	.97	1.06								
Fresno, Cal.	24			0.20														.09			
Galveston, Tex.	3	9.40 a.m.	10.45 a.m.	0.82	9.45 a.m.	10.33 a.m.	.02	.10	.20	.25	.32	.45	.55	.67	.80						
Do.	20–21	9.45 p.m.	12.20 p.m.	1.47	6.12 a.m.	6.44 a.m.	.25	.10	.24	.27	.35	.43	.50	.52							
Do.	23	6.35 a.m.	4.15 p.m.	2.07	7.38 a.m.	8.43 a.m.	.01	.31	.42	.50	.56	.64	.90	.92	1.06	1.23	1.33	1.52	1.64		
Grand Haven, Mich.	2			0.58														.39			
Grand Junction, Colo.	13			0.20														.08			
Grand Rapids, Mich.	2			0.75														.37			
Green Bay, Wis.	17	4.50 a.m.	11.55 a.m.	2.81	6.44 a.m.	7.55 a.m.	.22	.15	.31	.36	.45	.52	.70	.82	.84	.86	.95	1.10	1.28		
Hannibal, Mo.	1–2	4.55 p.m.	D.N. a.m.	1.32	8.48 p.m.	9.09 p.m.	.25	.10	.30	.63	.83	.86									
Harrisburg, Pa.	2			0.18														.18			
Hartford, Conn.	30			0.08														.07			
Hatteras, N. C.	25	8.50 a.m.	3.00 p.m.	1.91	11.09 a.m.	11.45 a.m.	.24	.07	.11	.20	.33	.45	.56	.71	.75						
Havre, Mont.	12			0.74														.14			
Helena, Mont.	12			0.75														.19			
Houghton, Mich.	1			0.30														.23			
Houston, Tex.	21	D.N. a.m.	6.30 a.m.	0.58	5.13 a.m.	5.24 a.m.	.09	.26	.37	.39											
Huron, S. Dak.	12	2.00 p.m.	5.10 p.m.	0.65	4.06 p.m.	4.17 p.m.	.04	.14	.52	.56											
Independence, Cal.	25			0.18														.13			
Indianapolis, Ind.	2	12.18 a.m.	D.N. a.m.	0.55	12.31 a.m.	12.44 a.m.	.01	.10	.27	.36											
Iola, Kans.	8	4.35 p.m.	7.12 p.m.	1.53	6.07 p.m.	6.47 p.m.	.59	.05	.13	.18	.38	.45	.50	.64	.90						
Jacksonville, Fla.	24	5.14 p.m.	7.30 p.m.	1.37	5.40 p.m.	6.14 p.m.	.05	.33	.61	.85	1.08	1.20	1.23	1.30							
Kalispell, Mont.	14			0.33														.12			
Kansas City, Mo.	6.7	11.40 p.m.	9.50 a.m.	6.94	11.49 p.m.	12.18 a.m.	.01	.20	.84	1.15	1.38	1.51	1.56								
					5.44 a.m.	9.01 a.m.	2.39	.11	.20	.38	.63	.80	1.04	1.21	1.31	1.43	1.61				
								1.77	1.90	2.06	2.15	2.27	2.44	2.60	2.64	2.68	2.77				
								2.88	2.94	2.98	2.99	3.01	3.11	3.19	3.32	3.45	3.59				
								3.64	3.75	3.78	3.82	3.85	3.88	3.98	4.25	4.33	4.37				
Do.	10	8.03 a.m.	10.30 a.m.	2.11	8.09 a.m.	9.32 a.m.	.03	.10	.28	.39	.54	.64	.79	.93	.99	1.01	1.04	1.07	1.90	2.07	
Do.	15	6.33 a.m.	8.50 a.m.	3.59	6.36 a.m.	7.59 a.m.	.01	.19	.35	.47	.68	.91	1.19	1.74	2.28	2.76	2.90	2.93	3.41	3.51	
Do.	21–22	9.35 p.m.	D.N. a.m.	1.99	10.18 p.m.	11.07 p.m.	.24	.16	.36	.43	.64	.79	.95	1.06	1.10	1.19	1.26				
Keokuk, Iowa	1	4.25 p.m.	5.35 p.m.	0.71	5.15 p.m.	5.28 p.m.	.30	.21	.33	.40											
Key West, Fla.	13	2.05 p.m.	2.35 p.m.	0.87	2.09 p.m.	2.22 p.m.	.01	.32	.70	.84											
Do.	22	8.23 a.m.	9.12 a.m.	1.01	8.31 a.m.	9.00 a.m.	.02	.16	.44	.57	.76	.89	.97								

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during September, 1914, at all stations furnished with self-registering gages*—Continued.

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Knoxville, Tenn	24			0.63														.17			
La Crosse, Wis	14			1.46														.40			
Lander, Wyo	15			T.														T.			
Lansing, Mich	1	D.N. a.m.	7.00 a.m.	1.68	2.16 a.m.	3.23 a.m.	.12	.14	.22	.33	.36	.39	.50	.56	.59	.61	.64	.77	.99		
Lewiston, Idaho	19			0.18														.13			
Lexington, Ky	23			0.89														.29			
Lincoln, Nebr	7	8.53 a.m.	9.17 a.m.	0.61	8.57 a.m.	9.10 a.m.	.01	.36	.55	.59											
Do	8-9	9.15 p.m.	5.50 a.m.	3.31	12.41 a.m.	1.20 a.m.	1.05	.08	.25	.44	.58	.76	.98	1.13	1.20						
					2.02 a.m.	2.57 a.m.	1.33	.14	.26	.46	.61	.76	.96	1.13	1.24	1.38	1.48	1.58			
Do	10	1.45 a.m.	4.20 a.m.	1.62	1.57 a.m.	2.56 a.m.	.08	.05	.19	.54	.74	.89	.98	1.02	1.12	1.16	1.21	1.39			
Little Rock, Ark	4	9.50 a.m.	10.45 a.m.	0.42	10.21 a.m.	10.33 a.m.	.08	.09	.28	.34											
Los Angeles, Cal	0			0.00														.00			
Louisville, Ky	23			0.95														.19			
Ludington, Mich	14-15	8.05 p.m.	D.N. a.m.	1.79	8.20 p.m.	9.17 p.m.	.03	.20	.36	.48	.57	.64	.70	.73	.77	.79	.85	1.02			
					2.27 a.m.	2.45 a.m.	1.16	.06	.30	.47	.56										
Lynchburg, Va	8			0.09														.08			
Macon, Ga	24-25	11.48 a.m.	D.N. a.m.	3.71	12.24 p.m.	1.24 p.m.	.05	.10	.19	.22	.34	.63	.95	1.14	1.30	1.41	1.49	1.69			
Madison, Wis	14	12.15 p.m.	D.N. p.m.	2.63	8.37 p.m.	8.47 p.m.	1.83	.17	.31												
Marquette, Mich	15			0.20														.17			
Memphis, Tenn	2	6.19 a.m.	8.25 a.m.	0.60	7.03 a.m.	7.28 a.m.	.07	.13	.29	.37	.39	.46									
Meridian, Miss	23			1.31														.67			
Miami, Fla	6	1.22 p.m.	7.40 p.m.	2.20	1.23 p.m.	2.04 p.m.	.01	.13	.51	.90	1.39	1.64	1.80	1.94	2.03	2.05					
Do	12-13	10.48 p.m.	D.N. a.m.	1.37	11.46 p.m.	12.23 a.m.	.09	.32	.53	.62	.83	.97	1.08	1.17	1.23						
Milwaukee, Wis	14-15	5.35 p.m.	D.N. a.m.	2.59	5.57 p.m.	7.38 p.m.	.04	.19	.42	.49	.61	.73	.88	.95	1.05	1.20	1.27	1.38	1.77	2.12	2.17
Minneapolis, Minn	14	D.N. a.m.	D.N. a.m.	0.90	1.37 a.m.	1.57 a.m.	.06	.20	.36	.38	.61										
Mobile, Ala	24	D.N. a.m.	4.50 p.m.	1.50	1.40 a.m.	1.53 a.m.	.01	.30	.45	.54											
Modena, Utah	27			0.19														.18			
Montgomery, Ala	11	1.45 p.m.	2.40 p.m.	0.66	2.08 p.m.	2.22 p.m.	.07	.17	.45	.55											
Moorhead, Minn	12			0.69														.23			
Mount Tamalpais, Cal	18			0.11														.03			
Mount Weather, Va	24			0.41														.16			
Nantucket, Mass	30			0.71														.30			
Nashville, Tenn	23			1.19														.36			
New Haven, Conn	24-25			0.12														.04			
New Orleans, La	12	4.10 p.m.	8.35 p.m.	1.28	6.42 p.m.	7.07 p.m.	.41	.09	.32	.55	.61	.69									
Do	14	10.30 a.m.	11.45 a.m.	0.64	10.55 a.m.	11.12 a.m.	.02	.17	.45	.58	.61										
New York, N. Y	24			0.09														.09			
Norfolk, Va	12			0.86														.39			
Northfield, Vt	2			0.26														.19			
North Head, Wash	18			0.37														.14			
North Platte, Nebr	13			0.09														(*)			
Oklahoma, Okla	22	D.N. a.m.	9.20 a.m.	1.30	4.16 a.m.	4.54 a.m.	.04	.14	.16	.19	.24	.28	.39	.57	.76						
Omaha, Nebr	7	6.45 a.m.	9.50 a.m.	0.72	9.02 a.m.	9.24 a.m.	.08	.07	.12	.22	.52	.57									
Oswego, N. Y	7			0.24														.24			
Palestine, Tex	22	4.30 p.m.	11.35 p.m.	1.66	4.32 p.m.	4.56 p.m.	T.	.28	.45	.60	.71	.75									
Parkersburg, W. Va	24			0.41														.10			
Pensacola, Fla	11	5.40 p.m.	7.30 p.m.	0.86	5.45 p.m.	6.10 p.m.	.01	.13	.36	.52	.67	.73									
Do	17-18	11.50 a.m.	12.10 p.m.	4.76	5.25 a.m.	5.56 a.m.	1.76	.05	.07	.16	.23	.38	.60	.63							
					6.27 a.m.	7.11 a.m.	2.55	.13	.20	.24	.36	.44	.55	.58	.73	.81					
					10.08 a.m.	10.37 a.m.	4.12	.05	.17	.27	.29	.42	.59								
Do	30	2.25 a.m.	6.30 a.m.	2.42	3.27 a.m.	5.12 a.m.	.18	.11	.16	.20	.35	.43	.49	.56	.61	.74	.89	1.24	1.54	1.81	2.04
Peoria, Ill	1-2	5.33 p.m.	1.30 a.m.	1.61	6.53 p.m.	7.23 p.m.	.08	.30	.54	.76	.95	1.15	1.22								
Do	5-6	11.43 p.m.	2.30 a.m.	1.23	11.52 p.m.	12.22 a.m.	.01	.06	.18	.29	.37	.42	.50								
Do	14-15	11.37 p.m.	4.00 a.m.	1.55	12.16 a.m.	1.19 a.m.	.24	.07	.14	.30	.36	.46	.63	.74	.83	.84	.97	1.22	1.30		
Philadelphia, Pa	24			0.69														.51			
Phoenix, Ariz	16			T.														T.			
Pierre, S. Dak	1			0.46														.13			
Pittsburgh, Pa	2			0.19														.18			
Pocatello, Idaho	18	5.15 p.m.	D.N. p.m.	0.44	5.35 p.m.	5.43 p.m.	T.	.35	.38												
Point Reyes Light, Cal	18			0.15														.06			
Port Huron, Mich	1			1.18														.41			
Portland, Me	1			0.39														.35			
Portland, Oreg	7			0.59														.18			
Providence, R. I	4			0.14														.11			
Pueblo, Colo	22			0.09														.09			
Raleigh, N. C	3	1.57 p.m.	6.18 p.m.	1.46	2.34 p.m.	3.19 p.m.	.08	.21	.30	.57	.85	.94	1.05	1.10	1.20	1.27					
Do	17	6.48 p.m.	8.36 p.m.	0.98	6.56 p.m.	7.13 p.m.	.02	.35	.57	.60	.64										
Rapid City, S. Dak	6			0.27														.24			
Reading, Pa	2			0.14														.14			
Reno, Nev	24			0.05														.04			
Richmond, Va	17			0.37														.30			
Rochester, N. Y	6			0.28														.27			
Roseburg, Oreg	16			1.16														.19			
Roswell, N. Mex	10			0.04														.04			
Sacramento, Cal	17			T.														T.			
Saginaw, Mich	6			0.52														.39			
St. Joseph, Mo	7	9.00 a.m.	11.00 a.m.	0.87	10.26 a.m.	10.41 a.m.	.25	.10	.44	.62											
Do	9	12.45 a.m.	D.N. a.m.	1.23	12.50 a.m.	1.36 a.m.	.01	.10	.28	.57	.77	.81	.82	.84	1.04	1.13	1.18				
St. Louis, Mo	1	12.50 p.m.	2.00 p.m.	1.87	1.18 p.m.	1.55 p.m.	.10	.20	.47	.84	1.22	1.31	1.50	1.70	1.76						
Do	5	5.35 a.m.	11.25 a.m.	1.89	5.54 a.m.	7.09 a.m.	.14	.22	.40	.41	.41	.43	.53	.59	.60	.60	.61	.77	1.30		
Do	14-15	11.32 p.m.	4.55 a.m.	2.05	12.34 a.m.	2.00 a.m.	.07	.14	.25	.41	.56	.75	.91	1.08	1.19	1.30	1.40	1.49	1.63	1.82	
St. Paul, Minn	1			0.58														.50			
Salt Lake City, Utah	12			0.09														.09			
San Antonio, Tex	22	3.28 p.m.	11.20 p.m.	1.89	6.46 p.m.	7.28 p.m.	.19	.29	.50	.76	.96	1.09	1.25	1.34	1.37						
San Diego, Cal	26			T.														T.			
Sand Key, Fla	3	7.37 a.m.	11.25 a.m.	0.62	7.42 a.m.	7.57 a.m.	.01	.27	.45	.52											
Do	6	6.24 p.m.	11.15 p.m.	1.81	6.26 p.m.	7.37 p.m.	.01	.15	.42	.55	.63	.69	.73	.75	.82	.97	1.09	1.35	1.58		
Do	10	6.22 p.m.	7.45 p.m.	0.56	6.24 p.m.	6.42 p.m.	.01	.20	.34	.47	.52										
Do	20	8.00 a.m.	8.55 a.m.	0.64	8.17 a.m.	8.42 a.m.	.04	.15	.29	.41	.47	.55									
Do	22	3.42 p.m.	4.30 p.m.	0.57	3.44 p.m.	3.57 p.m.	.02	.19	.42	.51											
Sandusky, Ohio	2			0.46														.29			
San Francisco, Cal	7			T.														T.			
San Jose, Cal	0			0.00														.00			
San Luis Obispo, Cal	24			T.														T.			
Santa Fe, N. Mex	22			0.16														.16			
Sault Ste. Marie, Mich	1	D. N. a.m.	D. N. a.m.	0.74	2.49 a.m.	2.56 a.m.	.31	.32	.43												
Savannah, Ga	16-17	5.36 p.m.	7.30 a.m.	1.68	12.40 a.m.	1.25 a.m.	.62	.06	.26	.33	.37	.44	.52	.56	.77	.99					
Scranton, Pa	2-3	7.09 p.m.	D. N. a.m.	0.53	7.17 p.m.	7.39 p.m.	.01	.14	.22	.33	.44	.49									
Seattle, Wash	7			0.19														.12			

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during September, 1914, at all stations furnished with self-registering gages*—Continued.

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated. 5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Sheridan, Wyo	12			0.27														.19			
Shreveport, La	23			0.11														.06			
Sioux City, Iowa	9	5.25 p. m.	11.40 p. m.	3.55	8.33 p. m.	11.07 p. m.	.79	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)			
Spokane, Wash	14			0.23														.10			
Springfield, Ill	1–2	7.55 p. m.	D. N. a. m.	1.43	8.12 p. m.	9.11 p. m.	.01	.11	.38	.52	.60	.64	.64	.67	.69	.79	.89	1.03			
Springfield, Mo	15			1.72														(*)			
Syracuse, N. Y	2			0.86														.52			
Tacoma, Wash	7			0.37														.18			
Tampa, Fla	1	3.03 p. m.	5.00 p. m.	0.62	3.07 p. m.	3.23 p. m.	.02	.15	.29	.52	.54										
Do	2	2.26 p. m.	6.55 p. m.	1.28	2.29 p. m.	3.20 p. m.	.01	.16	.35	.52	.66	.76	.83	.87	.90	.97	1.08	1.12			
Do	3	3.43 p. m.	6.10 p. m.	0.74	4.03 p. m.	4.33 p. m.	.07	.11	.29	.40	.46	.51	.58								
Do	17	5.05 p. m.	8.45 p. m.	1.61	5.14 p. m.	5.46 p. m.	.01	.19	.55	.94	1.11	1.25	1.39	1.43							
Tatoosh Island, Wash	18			0.87														.23			
Taylor, Tex	22			0.91														.62			
Terre Haute, Ind	6			0.57														.45			
Thomasville, Ga	3	2.10 p. m.	4.45 p. m.	2.20	3.21 p. m.	4.11 p. m.	.39	.15	.29	.47	.78	.97	1.17	1.36	1.50	1.60	1.67				
Do	24	1.48 p. m.	D.N. p. m.	2.31	8.20 p. m.	9.00 p. m.	.65	.06	.16	.46	.82	1.02	1.24	1.42	1.63						
Toledo, Ohio	6			0.80														.44			
Tonopah, Nev	25			0.22														.08			
Topeka, Kans.	7	3.50 a. m.	7.15 a. m.	1.40	5.37 a. m.	6.51 a. m.	.06	.09	.13	.23	.35	.43	.51	.76	.79	.81	.88	1.00	1.33		
		5.03 p. m.	6.13 p. m.	0.64	5.05 p. m.	5.41 p. m.	.01	.17	.23	.25	.27	.31	.44	.55	.59						
Do	14	1.40 p. m.	3.05 p. m.	0.98	2.15 p. m.	2.56 p. m.	.01	.29	.51	.55	.56	.58	.66	.77	.93	.97					
Do	21	8.33 p. m.	10.55 p. m. (about)	1.25	9.12 p. m.	9.47 p. m.	.06	.15	.23	.29	.43	.64	.82	.98							
Valentine, Nebr	7	12.30 a. m.	4.30 a. m.	1.53	1.15 a. m.	2.05 a. m.	.39	.13	.17	.26	.32	.44	.49	.55	.68	.71	.76				
Vicksburg, Miss	12	5.17 a. m.	6.53 a. m.	1.36	5.59 a. m.	6.35 a. m.	.09	.34	.61	.70	.95	1.09	1.15	1.21	1.26						
Walla Walla, Wash	26			0.30														.27			
Washington, D. C	11			0.26														.20			
Wichita, Kans	21–22	7.20 p. m.	8.00 a. m.	1.65	7.23 p. m.	7.54 p. m.	.01	.07	.29	.46	.56	.61	.71	.74							
Williston, N. Dak	7			0.17														.13			
Wilmington, N. C	8	6.40 p.m.	7.40p. m.	1.00	6.48 p. m.	7.09 p. m.	.01	.24	.47	.60	.80	.86									
Winnemucca, Nev	15			0.35														.16			
Wytheville, Va	11			0.72														.20			
Yankton, S. Dak	13			1.25														.51			
Yellowstone Park, Wyo	14–15			0.84														(*)			

* Self-register not working.

TABLE III.—*Data furnished by the Canadian Meteorological Service, September, 1914.*

Stations.	Pressure. Station reduced to mean of 24 hours.	Pressure. Sea level reduced to mean of 24 hours.	Pressure. Departure from normal.	Temperature. Mean max. + mean min. ÷ 2.	Temperature. Departure from normal.	Temperature. Mean maximum.	Temperature. Mean minimum.	Temperature. Highest.	Temperature. Lowest.	Precipitation. Total.	Precipitation. Departure from normal.	Precipitation. Total snowfall.
	Inches.	*Inches.*	*Inches.*	° F.	° F.	° F.	° F.	° F.	° F.	*Inches.*	*Inches.*	*Inches.*
St. Johns, N. F	29.66	29.80	–.17	53.2	–0.8	60.2	46.2	82	34	3.59	–0.12	
Sydney, C. B. I	29.91	29.95	–.06	57.9	+1.4	66.7	49.2	87	36	1.20	–2.08	
Halifax, N. S	29.91	29.91	–.13	58.4	+0.8	69.4	47.3	86	33	3.59	–0.12	
Yarmouth, N. S	29.98	30.05	+.01	55.2	–0.9	62.4	48.0	74	36	2.10	–1.35	
Charlottetown, P. E. I	29.95	29.99	–.02	58.0	+0.7	66.2	49.7	82	36	2.75	–0.65	
Chatham, N. B	30.00	30.02	+.02	58.2	+2.8	68.3	48.2	91	35	2.03	–0.68	
Father Point, Que	30.00	30.02	+.04	50.4	0.0	57.2	43.7	76	30	2.21	–0.92	
Quebec, Que	29.75	30.07	+.06	56.4	+1.3	65.0	47.8	83	27	5.10	+1.43	
Montreal, Que	29.89	30.09	+.05	58.8	+0.4	66.7	50.8	84	32	2.56	–0.74	
Stonecliffe, Ont	29.51	30.11	+.08	56.2	+0.5	68.9	43.4	91	31	2.79	–0.49	
Ottawa, Ont	29.86	30.18	+.14	57.0	–0.4	66.6	47.3	88	31	2.54	–0.15	
Kingston, Ont	29.83	30.14	+.10	58.5	–1.5	67.2	49.8	78	36	2.08	–0.72	
Toronto, Ont	29.74	30.11	+.05	61.0	+2.0	71.2	50.8	87	37	1.54	–1.71	
White River, Ont	28.76	30.07	+.09	50.5	+0.2	63.6	37.4	81	20	2.07	–0.70	
Port Stanley, Ont	29.52	30.16	+.10	58.3	–1.2	67.3	49.3	79	34	2.22	–0.51	
Southampton, Ont	29.44			59.7	+2.2	68.7	50.7	86	32	0.87	–2.07	
Parry Sound, Ont	29.44	30.12	+.09	58.2	+2.2	68.7	47.6	85	31	2.82	–0.85	
Port Arthur, Ont	29.35	30.06	+.08	54.5	+2.3	63.0	46.0	80	34	2.70	–0.78	
Winnipeg, Man	29.10	29.92	–.02	57.0	+4.5	67.8	46.2	82	32	2.28	+0.25	
Minnedosa, Man	28.13	29.93	–.01	55.2	+4.7	68.5	41.9	84	28	2.30	+0.94	
Qu'Appelle, Sask	27.63	29.85	–.07	55.0	+3.9	68.3	41.8	87	29	0.58	–0.75	
Medicine Hat, Alberta	27.56	29.82	–.11	59.2	+4.2	73.0	45.5	89	35	1.40	+0.22	
Swift Current, Sask	27.28	29.82	–.10	54.3	+1.2	68.8	39.9	82	28	2.17	+1.95	20.0
Calgary, Alberta	26.29	29.64	–.28	53.3	+3.5	67.9	38.7	82	30	1.11	–0.25	
Banff, Alberta	25.32	29.88	–.05	47.3	+1.5	58.7	35.9	77	28	2.56	+0.89	9.2
Edmonton, Alberta	27.54	29.80	–.10	49.9	+0.6	61.3	38.5	79	29	2.94	+1.61	T.
Prince Albert, Sask	28.25	29.79	–.11	49.9	+1.5	59.2	40.6	76	30	1.12	–0.16	
Battleford, Sask	28.10	29.82	–.08	54.2	+2.4	65.7	42.7	80	30	3.97	+2.72	
Kamloops, B. C	28.65	29.86	–.11	56.5	–0.9	66.5	46.5	85	36	1.09	+0.24	
Victoria, B. C	29.71	29.80	–.21	53.6	–1.2	58.6	48.5	71	44	1.98	–1.18	
Barkerville, B. C	25.58	29.85	–.13	43.8	–2.9	52.5	35.2	66	23	3.75	+0.84	12.5
Hamilton, Bermuda	29.94	30.10	–.03	75.2	–2.2	81.4	68.9	87	61	6.60	+0.09	

○

Chart I. Hydrographs of Several Principal Rivers, September, 1914.

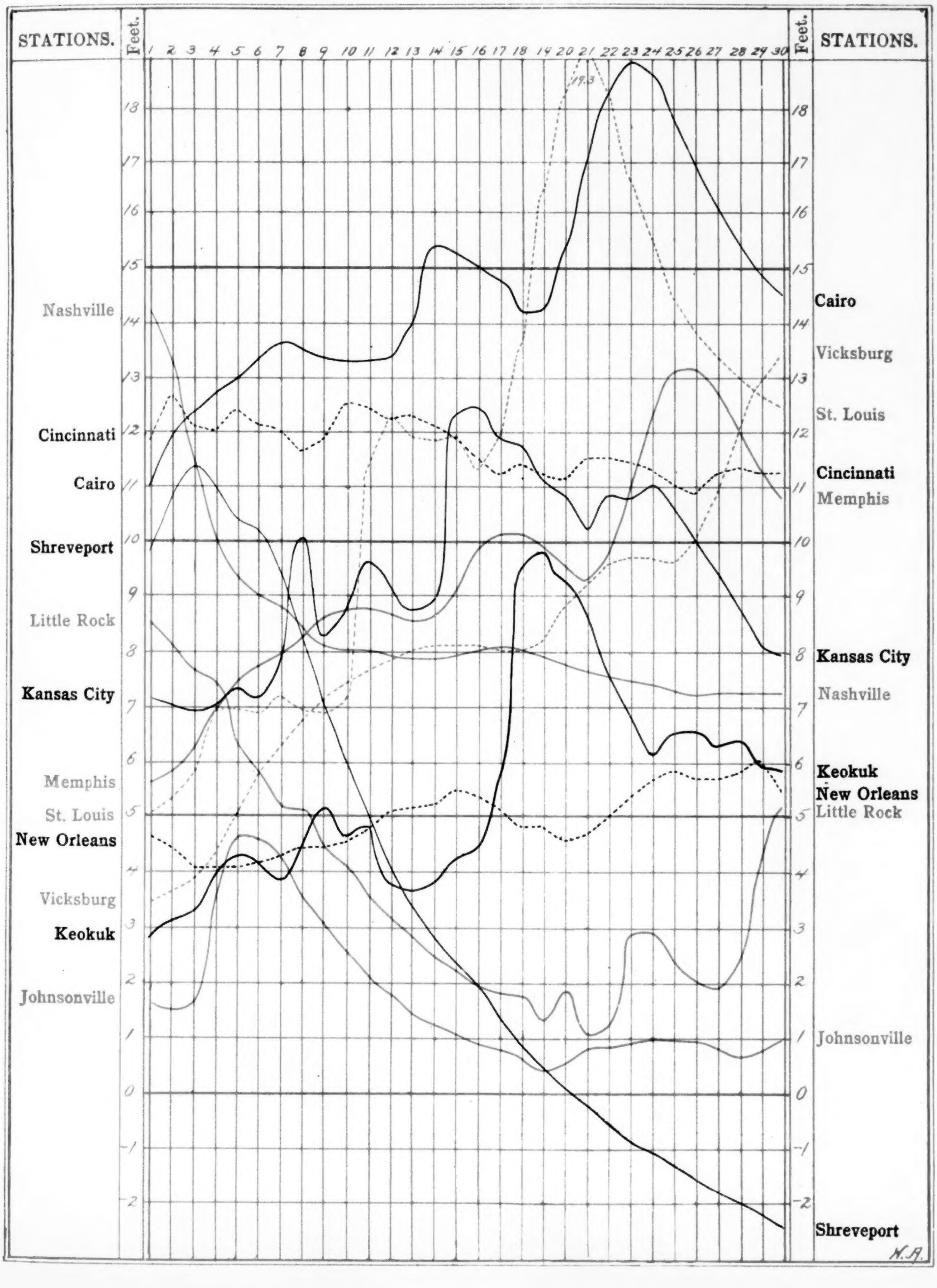


Chart II. Tracks of Centers of High Areas, September, 1914.

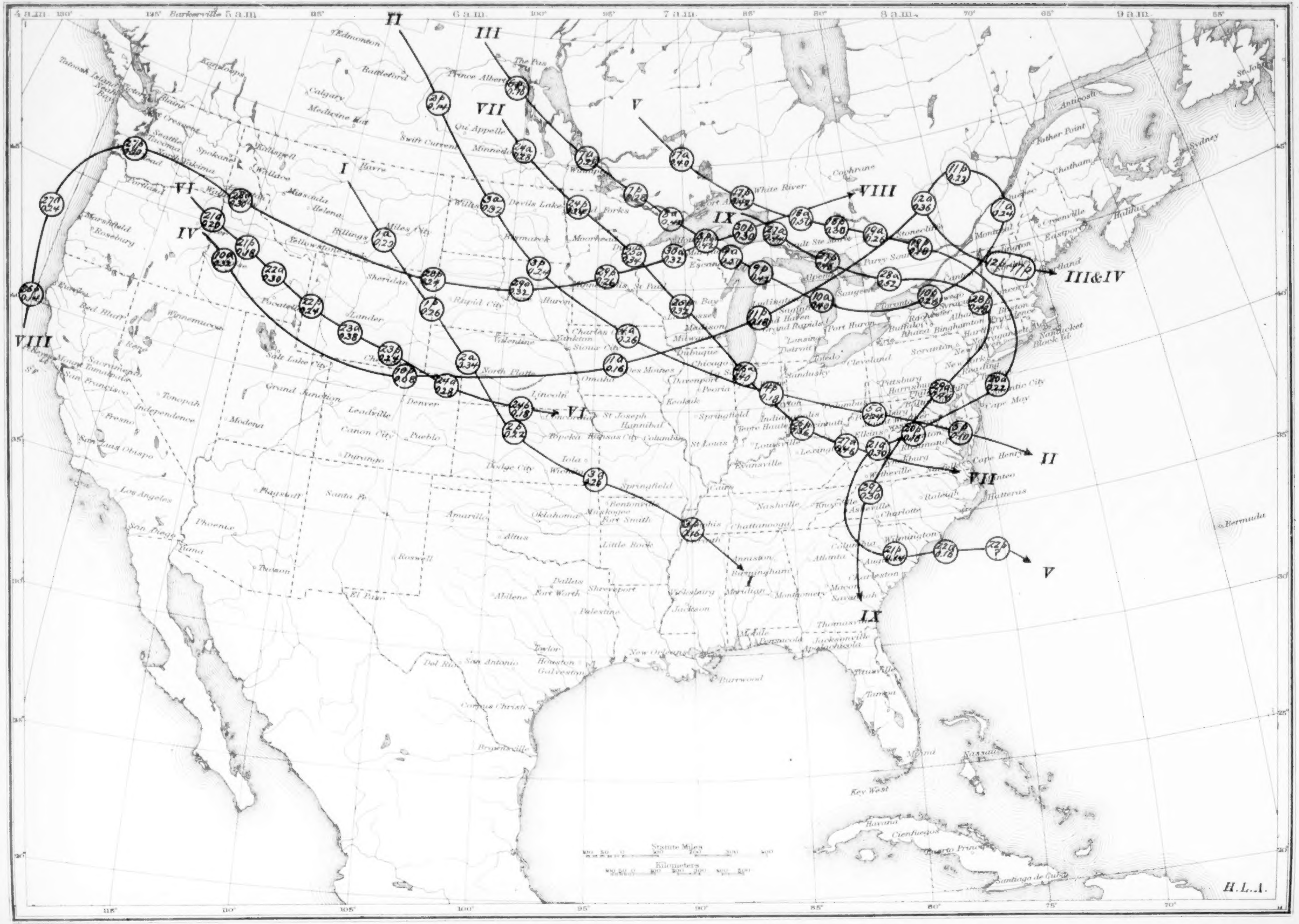
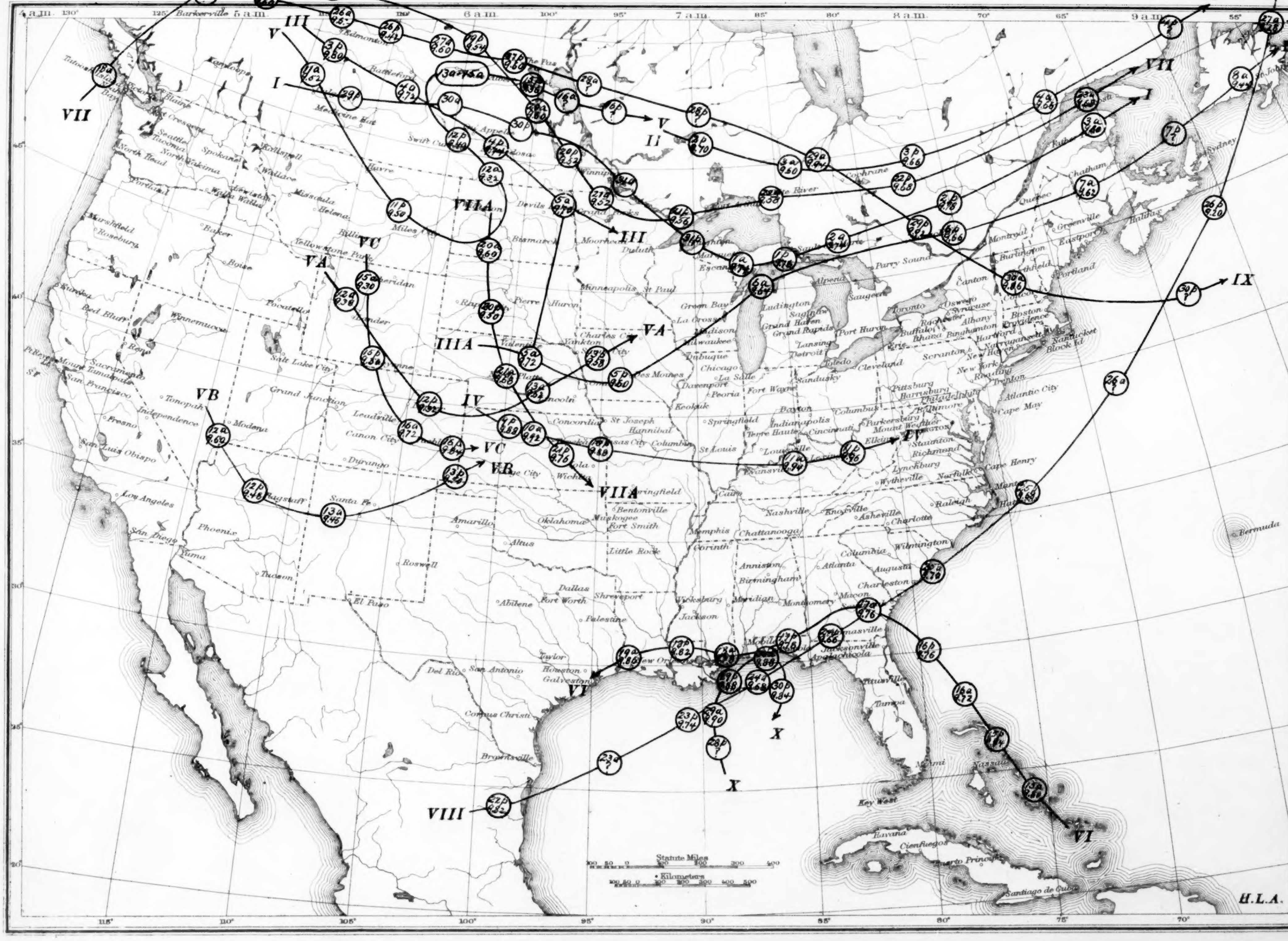


Chart III. Tracks of Centers of Low Areas, September, 1914.



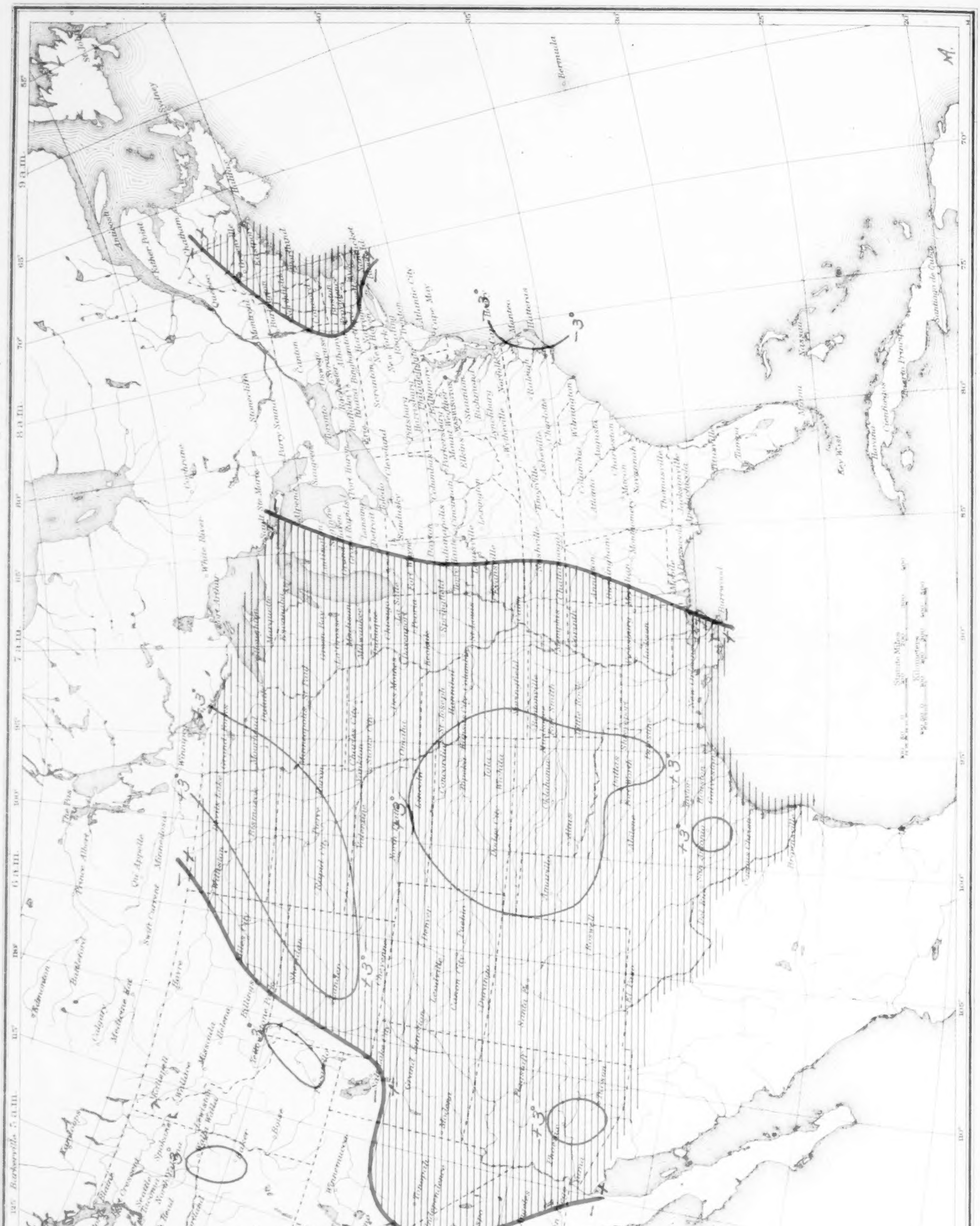


Chart IV. Departure of the Mean Temperature from the Normal, September, 1914.

Chart V. Total Precipitation, inches, September, 1914.

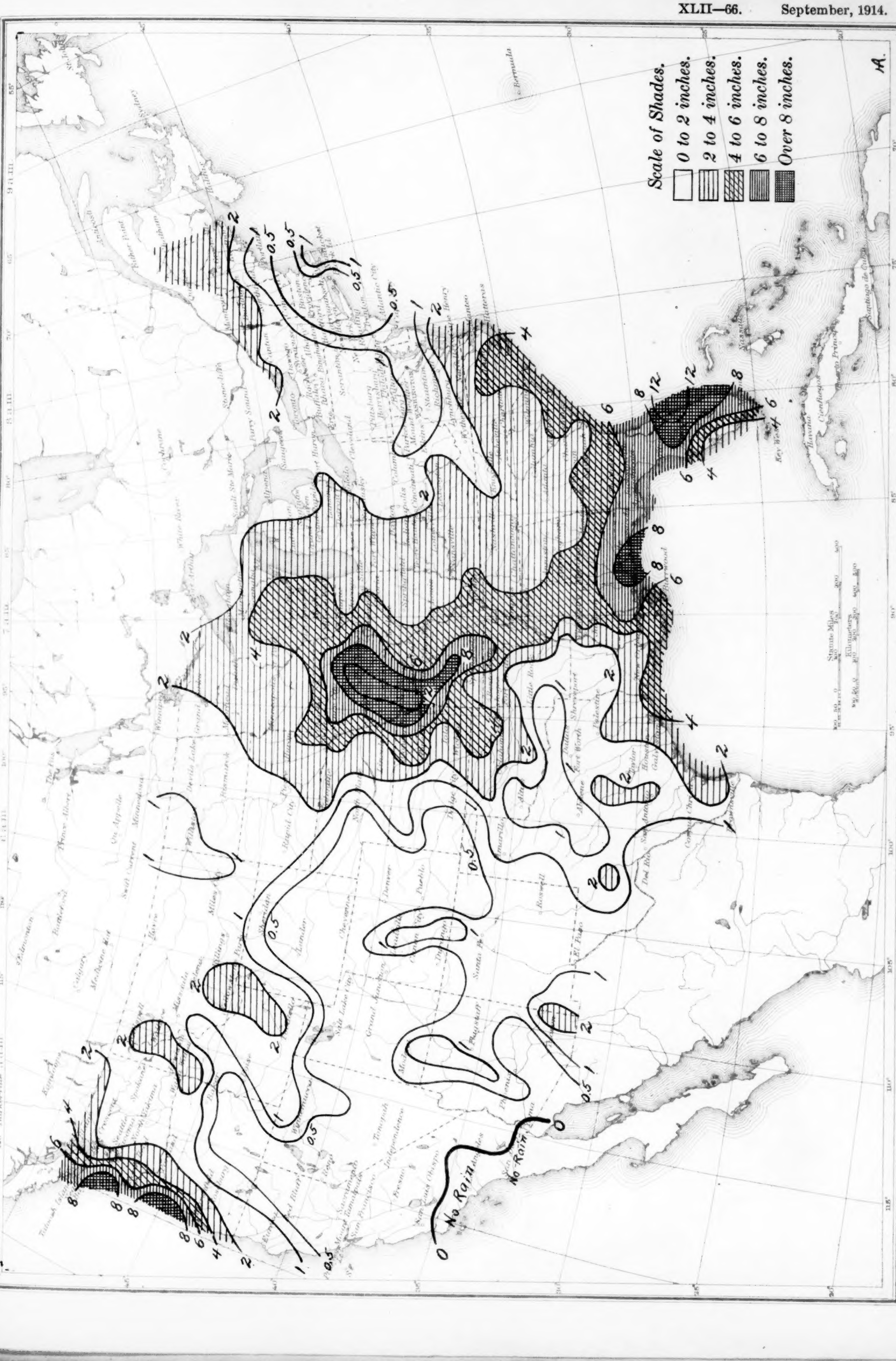


Chart VI. Percentage of Clear Sky between Sunrise and Sunset, September, 1914.

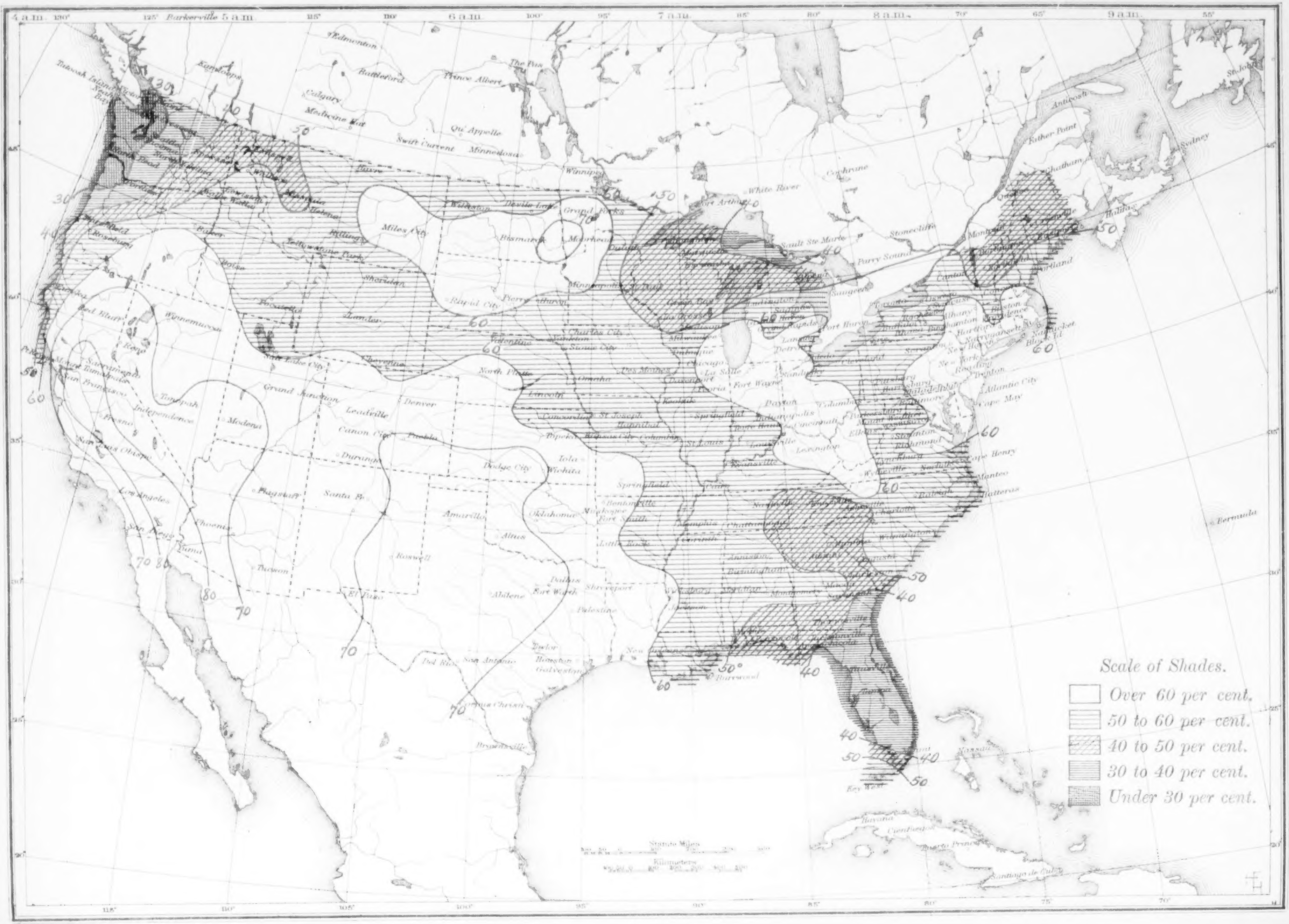


Chart VII. Isobars and Isotherms at Sea Level; Prevailing Winds, September, 1914.